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WASTE MANAGEMENT FACILITIES

Dr. Desmond M. Connor

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SOCIOLOGICAL CHALLENGES IN SITING

WASTE MANAGEMENT FACILITIES

Desmond M. Connor

Introduction

The siting of waste management facilities has proven to be difficult if not impossible, not only in the Hamilton area but across Ontario and Canada, primarily because of the opposition of various public groups. Since sociologists focus on the workings of people in groups, I appreciate this opportunity to talk with you on this subject. What follows is based upon experiences with a dozen waste management projects, principally in Ontario and including minor involvement at Glanbrook and Middleport.

Elected representatives and government officials are faced with a series of challenges when they undertake to find a site for a waste management facility. In most cases where controversies occur, one or more of these challenges were unrecognized or ignored.

Challenge #1 - Obtain a systematic understanding of the various publics and communities affected and involved.

Most waste management agencies, in my experience, possess a considerable body of information about the amount, type and location of the material they must dispose of, but have only the most impressionistic ideas about the people affected and involved. Since it is people who generate garbage, and people's objections which make its disposal difficult, effective waste management requires a systematic social data base on which plans can be developed and decisions made.

Who are the publics for waste management? They include: those who produce the waste; those who dispose of it; the neighbours of existing and possible future sites; environmental groups; the regulatory agencies and others. In many cases, these publics are represented by specific organizations e.g. community associations; waste management departments of local government or waste disposal companies; branches of provincial environment ministries etc. Note - the "general public" is too large and amorphous to deal with directly; it must be broken down into specific publics with particular interests which can be addressed in concrete terms.

Understanding each of these publics is the first step in being able to work with them effectively. Who are these people? What is important to them? How are they organized? Who are their leaders? What media can be employed to reach them? These are the questions which will provide the social data base for a sound waste management program. Few agencies possess this information, so most of them are in trouble with one or more of their publics.

The Social Profile (See Appendix 1) is a comprehensive summary of the key characteristics of the people of a community prepared to orient planners and managers to the social and cultural realities which they need to understand and deal with. There is a simple and proven method of preparing a Social Profile; the 10 days required to do so is often one of the most cost-effective investments an organization makes. By way of example, Transport Canada has authorized the preparation of social profiles at all major airports to assist airport managers and planners.

Challenge #2 - Identify and share the goals of the various parties and work to increase commitment to achieve them.

When the goals of those affected by a project are unknown or unclear,

effective co-operation is unlikely. Urban residents, environmentalists, farmers and others can be brought together through their organizations and develop an appreciation of what they have in common as well as their differences.

Through workshops or committee work, acceptance, understanding and shared commitment to action can develop. In the process, initial "hard line" stands by the various parties are often modified to a position which most can accept and support.

When regional planning is involved, there is often a good deal of ignorance, distrust and sometimes hostility between the various communities and organizations involved. Careful work is needed to develop the kind of positive relationships needed to create and implement a regional waste management plan.

Challenge #3 - Inform and involve the beneficiaries who usually form the silent majority.

In too many cases, the participants in a planning project are those who stand to lose something and are against it. The agency involved responds to these participants and thus contributes to a more informed and organized opposition. In the meantime those who stand to benefit are often unaware or regard the project with massive indifference. This is a recipe for disaster.

Instead, considerable effort must be invested to reach, inform and involve the beneficiaries of the project e.g. those whose garbage would pile up on the street if a waste management site is not found. Since their motivation is low, unlike the project's opponents, easy opportunities must be found to provide them with information, to spark their sense of civic responsibility and to seek their views for inclusion in the planning process.

In addition to working with the mass media to reach individual citizens, their community organizations must often be recruited to meet with the other interest groups e.g. environmental and agricultural, since these inhabitants of the same space have business to do with each other. After all, it is their community or region which has the problem of waste management so they should contribute to its solution e.g. arrive at some criteria for site selection. The agency is responsible to serve the whole community - a role which becomes difficult if not impossible when the agency becomes a protagonist for the silent general public and attracts the wrath of the special interest groups.

Challenge #4 - Design and manage a systematic process of public information and participation in the planning and decision-making process.

In too many cases, negative public participation is initiated by angry citizens towards the end of a site selection project, instead of the public being introduced positively by the waste management agency at the start of its planning process.

Today there is a use-tested approach available and accessible to all for constructive citizen participation. (See Appendix 2, which was published in 1972.) Since 1974, thousands of copies of a handbook, Citizens Participate, have been distributed across Canada and the U.S. Most planning schools now teach courses in participative planning. A quarterly newsletter, Constructive Citizen Participation, has been published for the last eight years.

The case study which follows illustrates how citizens can be positively involved as participants in selecting a waste management site. (Unfortunately, however, participation was terminated before the planning and decision-making process was completed.)

LOCATING A LANDFILL SITE IN HALTON REGION: A CASE STUDY*

1. Introduction

From August 1975 to July 1976, the Ontario Ministry of the Environment conducted a study to locate landfill sites and investigate the feasibility of a resource recovery plant for the Regional Municipality of Halton, some 25 miles west of Toronto. This paper focusses the public participation program connected with locating the landfill sites, outlining the problem, program design and operation; the results and some lessons learned in the process.

The study was directed by a Technical Coordinating Committee consisting of representatives of the Ministry, Halton Region and the four area municipalities. Technical work was carried out by a consortium of consulting firms: M.M. Dillon Ltd. (engineering); Ecoplans Ltd. (environmental assessment); Gartner-Lee Associates Ltd. (hydrogeology); Connor Development Services Ltd. (public participation).

Halton Region has a mixed urban and rural character - Burlington (111,000) and Oakville (71,000) lie along the shore of Lake Ontario, while to the north are Milton (24,000) and Halton Hills (34,000) and farms, small communities and the hills beyond the Niagara Escarpment. Some 240,000 people live in its 381 square miles.

2. The Problem

In October 1972 an agreement was reached between James F. MacLaren Ltd., a consulting engineering firm, and the then County of Halton to conduct a Solid Waste Management Study, including the location of landfill sites. A public participation program was included in the proposal, but was deleted as unnecessary by the County Council, reflecting the widespread feeling at the time that elected representatives could conduct all needed public activity.

*This paper was prepared for a conference "A Quarter Century Environmental Progress in the Hamilton area and a Blueprint for the Future", sponsored by the Pollution Control Committee of the City of Hamilton and held at Mohawk College, November 14,15, 1980. The author is a consulting sociologist and principal of Connor Development Services Ltd. of Oakville, Ontario

Two years and \$58,000 later the report's recommendations of some specific landfill sites triggered an unprecedented protest expressed in petitions, public meetings and the media. The report was shelved, but the existing sites were filling at a rate of 500 tons per day.

When the Ontario Ministry of the Environment decided to study the feasibility of a resource recovery plant for Halton Region in 1975, further investigation of additional landfill sites was incorporated as part of the feasibility study. Because of the time pressure to find new sites, this became the first priority of the study.

3. Participation Program Design

The design of the public participation program took into account the several waste management issues which had arisen previously in the Region, the sense of identity of its constituent communities which were still adjusting to regional government, and the need to coordinate with other planning studies underway e.g. Official Regional Plan study.

The objectives of the program were specified as:

1. to educate the people of the Region in the principal issues of resource recovery and solid waste disposal to create a more informed public;
2. to provide opportunities for interested persons and groups to contribute to evaluation criteria, alternative solutions and to the rating of technically sound alternative sites and methods of operation;
3. to provide a working model of how constructive citizen participation can contribute to identifying solid waste management decisions which are both technically sound and politically viable.

Assumptions

The successful introduction of a public participation program in a planning

study rests on a number of beliefs concerning human behaviour, inter-group relations, community organization and adult education. Those who raise such questions as "Why did you do that?" and "Why did it work that way?" may find some answers in this partial list of our working assumptions:

1. A Region consists of a number of partly related human systems, each with their own structures, processes and communications channels. Working effectively with the public means discovering and working through these existing mechanisms before supplementing them as needed.
2. For every group favouring or fighting a project, there is another group pushing in the opposite direction and several more on the sidelines. Effective solutions demand that these groups discover, respect and understand each other; workable compromises are then possible.
3. Public participation is essentially a process of mutual education for all of those involved--citizens, planners and politicians. Given a firm foundation of shared knowledge about the subject matter and about each other, there is a strong likelihood of co-operation resulting in mutually acceptable solutions for problems.
4. Since communities, persons and issues vary widely the design and management of a public participation program must be sensitive and responsive at all times.
5. Responsibility for the technical soundness of solutions remains with the planners. Similarly, responsibility for the final decision rests with the elected representatives who are aware of both the technical factors and public preferences concerning alternative solutions.

Work Program

The major components in the program of work drafted to achieve these objectives and accomodate these assumptions were: a project announcement to solicit interest, a social profile to identify key people, groups and communication channels, the distribution of basic background information,

the collection of evaluative criteria, weights and other suggestions, and the presentation of technically sound sites and solutions to obtain public preferences on them. The budget for this work, to be carried out from September to February, was \$33,500.

4. Participation Program

The first critical decision in this program was to secure a Citizen Participation Representative possessing training in the applied social sciences, familiar with the area, known and trusted by a number of persons and groups and willing to work the flexible hours and unconventional activities involved in this project. Fortunately, success occurred in less than one week in early September.

During the next month, a social profile of the Region was drafted based on data from visits to key persons and groups and the analysis of files and newspaper clippings. Some 50 relevant groups and organizations were identified and contacted. Seven regional newspapers, mainly weeklies, were recognized as the principal media contact, since radio and television coverage was dominated by major stations in Toronto, Hamilton and Buffalo. The attitudes and values of people in the four area municipalities and the still weak affiliation with the new Halton Region became clear.

An introductory brochure was drafted outlining the aims and work schedule of the study and inviting those interested to mail a detachable reply-paid postcard with their comments, suggestions and mailing address for future use. At this point (mid-September) some regional councillors sought to do away with the public participation program. The Ministry then suspended the entire study for three weeks, emphasizing that public participation was an integral part of the project. Two weeks after work resumed, a national postal strike commenced which lasted until December 3!

In early November, the brochure was printed in 5,000 copies, previewed

at a meeting with 20 of the 54 elected representatives in the study area, discussed at a newsconference with reporters and advertised in each regional paper. Copies were distributed through citizen organizations, libraries, municipal offices, and in response to telephoned requests following newspaper advertising.

Return postcards were collected at organization meetings and in boxes placed in libraries and municipal offices.

Contacts with the leaders of key environmental, agricultural and other groups led to a series of meetings in each area municipality with 10 - 15 of those leaders, the project manager and the Citizen Participation Representative. That is, the participation process occurred at two levels - the individual citizen and the group.

By mid-November, a substantial body of technical data had been developed, particularly about the hydrogeology of the Region. A tabloid was prepared to convey information about the main issues of the study and the results of the hydrogeological evaluation. In a tear-off coupon, readers were asked to rank 11 evaluative criteria. This four-page insert reached 65,000 homes in early December through five regional newspapers. A week later, a series of four Open Houses provided an opportunity for interested citizens and the study group to review information together and discuss priorities and possible solutions.

The Open House format was informal, inviting people to drop in from 10 a.m. to 9 p.m. Sixteen panels in sequence allowed visitors to follow the technical evaluation of the Region: members of the Technical Coordinating Committee and study team were present to answer questions.

Information was presented on ground and surface water, topography, drilled wells, hydrogeological evaluation, land use and major roads. A slide program on solid waste disposal was available continuously. Also presented were reference materials, fact sheets, and diagrams to explain the process of Resource Recovery using a plant and transfer stations.

Most people who came to the Open House were highly involved and concerned with issues embodied in the study. They spent considerable time with the display material and in discussions with the resource people present.

The results received from the tabloid and Open Houses were reviewed in mid-December and plans made for a final brochure describing some possible landfill locations and inviting people to rate them.

Following a preview for elected representatives and a news conference for the media, this brochure described the study to date, indicated 11 possible landfill areas and showed how each rated on 8 evaluative criteria. In a reply-paid postcard, readers were invited to rank the 11 locations and indicate their community. This brochure was distributed by householder mail to 67,000 households in mid-January. A week later, Open Houses were again held in the four principal communities of the Region.

The public response was tabulated by areas and reported to the Technical Co-ordinating Committee at the end of January. Since the public participation program was tied to the landfill site study, it was terminated with the preparation of the project report. There was no provision for continued public involvement in the second phase of the study dealing with resource recovery.

Subsequently, the most popular site (site G) was investigated further and found unsuitable; Site F later became the recommended location. A public meeting called by the Public Works Committee at the end of February attracted some 450 mostly hostile people from Site F and other locations.

In April, a modest public information program was provided by the Ministry of the Environment concerning the resource recovery study but did not address the landfill issues. By this time, the residents surrounding Site F had organized, raised funds and hired an environmental lawyer.

5. The Results

Due largely to the postal strike, the response to the introductory brochure was low i.e. 125 postcards. The main themes in the responses were a strong commitment to: long-range public education for waste reduction; a provincial policy and program for re-use and recycling; protection of the environment and the preservation of agricultural land.

Some 40 groups were contacted across the Region; two thirds were ratepayer associations, with the remainder being environmental groups, Chambers of Commerce etc. Personal visits were made to 115 community leaders, particularly during the first half of the study. The urban environmental and ratepayer groups generally supported resource recovery and the technical evaluation of areas suitable for landfill. Residents of rural north Halton were mainly concerned with the protection of surface and ground water, the preservation of farm land, and the disturbance by heavy trucks; response from this area was lower than in the south despite increased effort.

The low response rate from the tabloid was due largely to the disrupted postal service, and printing problems resulting in the omission of colour and a poorly laid out coupon. The 154 replies ranked water quality, agricultural land and site rehabilitation as the most important evaluation factors.

At the first round of Open Houses, personal conversation with over 200 enabled both visitors and study staff to obtain a better appreciation of the issues. While the numbers were light in some cases, it was politically necessary to hold an Open House in the principal communities in each of the four local municipalities constituting the Region.

Over 2,500 postcards were received from the final brochure, representing a 3.8% response. The first ranked Site G, which received 29% of the first choices across the Region, was rated the best in all four municipalities. (This disproves the old adage that everyone will vote to put it in some-one else's backyard. In addition, the second ranked site according to the people

living in Oakville was Site C, located within that community.) Some 300 people attended the four subsequent Open Houses enabling a better appreciation of the evaluation criteria and the proposed sites.

Media coverage during the study was positive and generous compared with other similar projects. During the first four months, over 1600 column inches of news and editorial space was provided.

In summary, the public participation program enabled the people of the Region to become informed and involved in the planning process for waste management. Unfortunately, it stopped too soon. Had a proposal, estimated at \$23,000, been accepted to continue the program for a further three months through the decision-making process of the Regional and provincial governments the results would, I am sure, have been different.

6. Epilogue

During the past six years, the Tremaine-Brittania Citizens Group has carried on a spirited defence of the area surrounding Site F. A recent estimate indicates that this group has spend \$50,000 - 75,000 on consultant and legal fees. The Town of Milton has spent close to \$200,000 for the same reasons; the Region of Halton indicated its costs to be about \$500,000. Each of the three expect to incur substantial costs at the forthcoming hearing of the Environmental Assessment Board i.e. the Tremaine-Britannia Citizens Group an estimated \$30,000 - 40,000; the Town of Milton some \$25,000 and the Region of Halton about \$150,000. In total, this is almost \$1,000,000, not counting provincial government expenses.

7. Observations and Conclusions

1. Changing values, including trends towards a conserver society, will make waste management increasingly difficult in the future.
2. The ingredients for a successful site selection program must include:

- a. clearly establishing the need for a facility;
 - b. developing a widespread sense of shared responsibility amongst the people of the service area, especially the latent and secondary beneficiaries. e.g. "We are all part of the problem - we must become part of the solution!"
 - c. providing complete information about the process, the alternative sites, the management system etc.;
 - d. involving elected representatives, government officials, citizen leaders and organizations and the public at large in appropriate ways;
 - e. establishing that the operator of the facility is reliable and trustworthy, perhaps backed by a local monitoring committee;
 - f. providing some benefits to the local area to offset the risks and negative effects;
 - g. ensuring that the site and its operation are not detrimental to other activities and enterprises in the area, or if so that such impacts are recognized, minimized and compensated.
 - h. convincing those concerned that the agency responsible has the proper regulations, resources and staff to make decisions and guarantee safe operation.
3. The continental trend from representative to participatory democracy in other fields will reinforce the need for public involvement in this issue.
 4. Building a participative Social Impact Assessment process into the planning and decision-making process will enable the agency to identify early the gains and losses accruing to different groups.
 5. The unwillingness of the Regional Council to support the public participation program initially, the substantial turnover of Council members after municipal elections and unresolved differences between the area municipalities and the Region, weakened the effectiveness of the public participation program.

Acknowledgement

Comments and suggestions received from Mr. Jack Corbett, Director of Public Works for the Region of Halton and Mrs. Carolyn Dutka, Citizen Participation Representative with the project, are gratefully acknowledged.

Social Profile Workshop

Desmond M. Connor

Definition

The social profile is a comprehensive summary of the key characteristics of the people of a community or study area. Its purpose is to orient planners, engineers and administrators to the social and cultural realities which they need to understand and take into account if a project, program or policy is to be accepted. Note - it can also be applied to a corporation or government agency by a citizen group.

Rationale

In the past, new policies and projects have often generated hostile public reactions because the proponents failed to understand and respond to the values, goals, concerns and views of the people affected. The social profile provides the core of a social data base needed to balance the technical information available to planners and decision-makers with an appreciation of the humanistic and political considerations involved.

For these key people to make sensitive decisions, they need a character sketch of the community so they can relate their responsibilities and proposals to it. From the social profile, they should grasp how and why this community is different to others, and how it is likely to respond to a new activity just as a personal profile of an individual enables a manager to judge how this person might respond to a new assignment.

Data Collection

First, review non-reactive sources of information many of which will often be available outside the community e.g. back issues of the weekly press; aerial photographs, preferably 10 years apart; local histories in the regional library; university theses and government reports on the community. Make a content analysis of this material, identifying information under key headings such as: community issues; active organizations; leaders; attitudes of growth; knowledge of and attitude to the client and/or the proposal etc.

Second, identify any people knowledgeable about the community who

live beyond it e.g. civil servants now in a provincial or regional centre who presently service the community or who used to live in it. Interview some of these people by telephone or face-to-face in an informal way e.g. have a list of issues and questions you want to explore, but allow the conversation to be flexible rather than pose them through a structured questionnaire.

Next, visit the community and initially immerse yourself in it, observing its people and how they spend their time and effort. Experience a day in the life of the community as unobtrusively as possible and reflect on how its residents view their world.

Now start to visit some key people and interview them informally. A conversation about the history of the community provides a comfortable starting point and usually yields many insights into leadership, issues, factions etc. Through it you will often be introduced to the elders of the community.

Look for people who have had long residence in the community, have high contact with its residents and are sufficiently secure in their positions that they can talk freely. Some of these are the public health nurse, leaders of voluntary associations, some business people, bank managers, clergy, the staff of service agencies, the school principal (and the janitor). Interview local government officials and elected representatives later so you will be better able to interpret their positions and discuss them in depth.

In talking with these people, explore subjects until you obtain a consistent position from at least three sources, e.g. if a certain organization appears to be a key factor in community decision-making according to (a) your analysis of the local weekly, (b) according to a provincial civil servant located in the capital but knowledgeable through his work in the community, and is (c) corroborated by two of these conversations in the community, count that as a fact established. You don't need to raise it in subsequent interviews, but can focus them on

other subjects which are still unclear. Note - this approach employs the navigator's technique of triangulation to establish facts with reasonable accuracy.

In some cases, the range of people interviewed is restricted by the fact that clients do not want their interest in the community to become public knowledge. However, there are usually some key people from whom valid information can be obtained and who are accustomed to working under these constraints. e.g. bank managers, clergy, provincial or federal civil servants etc.

The foregoing approach to data collection is always modified by the size and unique circumstances of each community.

Level of Effort

In my own practice, I usually allow a trained and experienced social researcher (typically with the equivalent of a master's degree in applied social science) ten days to complete a social profile. This usually breaks down into 1-1½ days of pre-entry work, 5-6 days in the community and the remainder to write the 30-40 page report. This has proven workable with small rural communities, regional municipalities and cities up to the size of Calgary and Edmonton.

The social profile is designed to provide a charcoal sketch of the main features of the people of the area and how they view and manage their world. Subsequently, it can readily be updated and carried out in greater depth, as may be needed, for example, as part of a Social Impact Assessment. However, it is not a substitute for a standard sociological study, using a random sample of the population; should this methodology be required, a previously prepared social profile can be very helpful in designing the questionnaire.

Using This Workbook

There are several ways of using this workbook:

- as a guide for assembly a social profile.
- as a stimulus for several people with experience of a given community to set down their observations about it individually and then review them in a group and identify areas of agreement, disagreement and omission. Follow-up work by the participants

or a social researcher would result in a completed profile and a sound foundation for plans and decisions.

- c. as a checklist against which to evaluate a social profile report.
- d. as a guide to updating an existing social profile which needs to reflect new issues and events, changes in leadership etc. since the original work was done.

Citizen Application

A citizen group may assemble a social profile of a corporation or government agency which it wishes to influence. For a comprehensive understanding of it, the same kind of information is required--the agency's history, organizational structure, internal management processes, values and goals, leadership (apparent and real), policies (stated and operational; vacuums and conflicts), recent performance in facing other issues, e.g. (labour, environment, community); patterns of influence and communications channels. A similar approach to gathering information is appropriate, i.e. use of non-reactive sources first such as reports, publications, press coverage, etc. Subsequently, current and former employees can be interviewed informally to provide insights into how the agency works. This may lead to co-operative relations between agency staff and citizen group members, with or without the agency's official approval. (Agencies which systematically

ignore their own staff's needs for knowledge and involvement concerning their work should not be surprised if disaffected staff leak information to opposing citizen groups).

The Report

The writing style must be simple and direct so that a busy manager or engineer can grasp the main points quickly and easily. Start with a map; eliminate jargon; omit heavy footnoting; place any large tables in an appendix, but first question if they are necessary. A photograph or two is often more informative use of space.

The introduction to the report should indicate the sources of data, the limitations on data collection, the level of effort invested and a request for comments and suggestions.

Following the usual table of contents, executive summary and map, the remaining chapters can follow the headings used on the succeeding pages.

In addition to a written report, some organizations which have to orient a number of project staff to the community will find it worthwhile to develop an audio-visual presentation of the social profile. This can be a simple one-projector production with a pulsed soundtrack, running perhaps 10 minutes; portable equipment can provide instant orientation

to visitors and new employees. e.g. a seismic crew can know ahead of time that a certain trapper they may come across is in fact the chief of the people in the area. This recognition could prevent a serious incident in the community-company relations.

Conclusion

The concept of the social profile and the foregoing methodology for assembling it has been developed over the past four years with particular help from Jillian M. Roulet and Miles S. Cullum. We have applied and use-tested it in more than 20 cases from small rural and native communities to major cities, and for a variety of clients.

I believe that the social profile is one of the most cost-effective investments an organization can make when it commences developing a new policy, program or project. By identifying the invalid perceptions and assumptions held by senior decision-makers and planners, it can root them firmly in the reality of the community and people affected; it also opens up new options for solving problems and making the most of opportunities.

I would be glad to have the views of experiences of others concerning both the concept of the social profile and its application.

1. Local History

- identify early settlement, key events and past leaders
- what are the trends in land use? note population trends e.g. age-sex distribution; migration; ethnic origin; occupations; education (see Census or planning studies)
- how does the history of the community help to explain its present position and character?

2. Industries & Occupations

- what are the main employers, markets, skills?
- how do these affect the community's behaviour?

3. Development Issues

- what issues arose in past 5 years; who got involved; what happened; how was each issue resolved?
- what are current issues and what, if anything is being done about them e.g. planning studies etc.?
- identify attitudes to growth
- what are the implications of the above for the agency and/or project?

4. Organizations & Leadership

- list the principal groups, their activities and officers, their role in the community
- identify and give a brief description of community leaders and influentials e.g. who have followers and are respected for their opinions.
- what does this imply for the proponent and its plans?

5. Communication Channels

- outline the formal media e.g. geographic coverage, capacity and credibility of each; circulation/audience of each.
- describe the informal networks - key nodes on grapevines; strategic listening posts in the community.
- what relevance have these channels for the agency and/or project?

6. Knowledge of and Attitudes to Client/Industry/Project

- what valid information, myths and areas of ignorance are evident in key people and groups?
- how does the above affect information and education requirements for the proposed activities?

7. Publics Affected

- summarize the key characteristics of each public e.g. language; education; media and grapevines appropriate; organizations and leaders relevant etc.
- what implications has this for the formation of a Citizen's Advisory Committee and other techniques?

8. Observations & Conclusions

- provide a succinct outline of how the characteristics of this community appear to affect the agency and/or project and their implications for a public participation program if required.

Other Notes

"From partisans to partners"


**Community
Techniques**

A technique for the integration of citizen participation into the planning process.

D.M. Connor B.Sc. M.Sc. Ph.D. *Consulting sociologist*

This outline is designed to convey my understanding of public participation as a constructive component in the total planning process. The approach has developed out of a background of community development, engineering, sociology and adult education.

What — the nature of public participation

For me, the public always participates in major decisions which people feel are important to them — but too often this participation is too little, too late and too negative to be constructive. Planners can therefore hardly choose whether or not to have public participation, but they can influence it to take a positive character.

For us, public participation in planning a project is a systematic process which provides an opportunity for citizens, planners, elected representatives and members of relevant area agencies to share their experience, knowledge and goals, and to combine their energy to create a plan. This plan can then reflect their knowledge and best judgment at the time and will be understood and actively supported by most of those affected by it.

Public participation is happening when :

planners listen to residents concerning their attitudes, goals, fears and factual suggestions; citizens find early and convenient opportunities to make positive contributions. ("Citizens" may include visitors as well as residents.) citizens learn from planners and others a broader and deeper knowledge and understanding of their environment, its potential and its fragility; individuals, interest groups and agencies are identifying their own positions, recognizing those of others and working towards a win-win solution co-operatively rather than becoming locked into a destructive win-lose or lose-lose syndrome; relationships between planners, politicians and other people are strengthened so that communication barriers are breached, and mutual trust increases as a foundation for communities to function more effectively in every way.

Public participation is NOT:

selling a pre-determined solution by public relations techniques; planning behind closed doors when information can be shared; one-way communication, e.g. planners telling people what is best for them;

- * public confrontations between "people power" versus the bureaucracy;
- * bypassing elected representatives or impairing their freedom to exercise their decision-making responsibilities.

Why — rationale for public participation

There are a number of reasons for engaging in public participation, ranging from technical considerations to political factors.

- 1 *Additional data*, important to planners, can be provided by persons who often have decades of year-round experience of the environment. When official records are often recent and the project does not permit a full year of original data collection, the systematic recruitment of local observations can supplement other data sources.
- 2 *Technical expertise* in the key subjects of the project is often possessed by residents of the area. They can contribute this valuable resource in support of the project or if alienated, can conspire powerfully against it. Constructively involving these people is a survival skill essential for project success!
- 3 *Creative capacity* for perceiving solutions to problems is not a prerogative of technical experts. Indeed, their training often equips them with as many blinkers as insights. Concerned laymen can often see sound alternatives which experts do not. e.g. a technically sound alternative route for No 417 in Ottawa was identified by a Citizens' Group; many teams of specialists had considered the problem for years without noticing this technically sound and widely acceptable solution.
- 4 *Data on goals, attitudes, values preferences and priorities* are a crucial input to the planning process. Their only valid sources are the citizens affected. Attempts to give people what planners think is best for them, or what planners think they want, have led to one debacle after another. Such disasters leave behind the original problem, a heavy financial expenditure with little to show for it and a corrosive residue of ill-will.
- 5 *Involvement* in planning is demanded by increasing numbers of citizens who want to experience the process of creation as well as its product. Often they have a substantial sense of ownership in their part of the environment — to ignore this is dangerous.
- 6 *Managerial solutions* for environmental problems (as opposed to purely structural solutions),

require changes in people's behaviour. The likelihood and ease of changing behaviour is greatly increased if people systematically become aware, interested, informed and thus convinced that new behaviour is needed. Placing new recommendations into traditional mentalities maximizes the need for regulatory legislation, enforcement procedures and a needless proliferation of a law and order society.

How — core elements of the program

The program must be based upon knowledge of the area, its people and its institutions and, as in any responsive program, is subject to revision as new information is obtained and new developments occur, especially in the technical side of the planning process (see chart). A typical 12 month's program is as follows :

1 *Introduction and start-up phase* (1 month)

Recruit, select and orient fieldstaff. Prepare introductory brochure for mailing and use with initial contacts.

2 *Initial data collection* (3 months)

Fieldstaff contact key people and organizations to discover the character of the communities, citizens' goals and their implications for the project, local issues, and knowledge of study Subjects important to later decisions. (Note — where possible, meetings needed would be called under the sponsorship of an appropriate local organization. Committee members would be informed of these meetings and, with the concurrence of the sponsoring organization, would be able to attend as resource persons or observers.)

3 *Mutual education* (6 months)

Following a preview by the Committee and a briefing for elected representatives and their guests, this phase would commence. Background data on study subjects assembled by the research team, together with several known alternatives, would be summarized in a 4-8 page tabloid newspaper supplement distributed through the local press. Assistance would be given to radio and television stations to foster complete coverage including some preliminary advertising to alert citizens to the forthcoming publication.

Contents would include the purpose of the study, background data on core subjects e.g. population, land use, etc. On the final page, readers would be invited to :

place priorities on a list of criteria, identified by fieldstaff at local meetings, which respondents feel should be employed in deciding the best use of the area; suggest alternative solutions either individually or through their local organizations preparing a written proposal; note their name and location.

An incubation period of up to two weeks would be given before the deadline for mailing individual responses; a further four weeks would be allowed for group presentations.

To reduce demands on the study office, some kits of basic background material would be provided to interest groups and placed in portable reference centres located in local body offices and public libraries.

Responses, individual and group, would be tabulated by areas, summarized, passed to the planning team, previewed by the Committee and shared with the public through the media. The constructive discussion of the results between various organizations would be fostered according to the issues raised and the parties interested.

Response to alternatives (1 month)

When the research and planning teams have defined some technically viable alternative solutions, together with descriptive data on each, this material would be previewed and published in a manner similar to No 3 above. In this case, readers could be given a simple matrix showing the criteria (plus the average weights they allocated to them earlier) and the alternatives. They would be invited to either simply mark their first, second, etc. preference or to do so after working through the matrix (In Ottawa recently over 3,000 did the matrix while over 5,000 simply gave their preferences, despite poor typography).

After a two week incubation period again, individual responses would be mailed in, tabulated by area, summarized and the results passed on to the Committee and the public through the media.

5 Decision (1 month)

Technical and public preference data would be provided for each viable alternative solution, so that the client and other decision-making organizations would be assisted in discharging their responsibilities and the results communicated to the public.

Who - staff requirements

To carry out this program effectively requires a high level of staff competence and a level of other resources which will ensure that most citizens have a realistic opportunity to learn about the issues and express their preferences on them. To do less is to invite needless trouble.

The staff skills required are demonstrated by a proven capacity to carry out community research, group work and adult education. A master's degree in one of the social or behavioural sciences, followed by at least three years' successful field experience, is usually the background of the successful community relations worker. The capacity to focus on interpersonal and intergroup processes is critical to the success of these persons.

An interpretive writer is required on a part time basis to prepare material for public use and to coordinate information for the media. Statistical clerks will be obtained as needed to tabulate the responses indicating public preference.

How much - budget estimate

The budget must be based on realistic expectations of the work to be done. However, in a responsive program, it is impossible to predict with assurance, since there is no way of knowing

in advance how many citizens will respond, how many study groups will form, how many issues will require what level of response, etc.

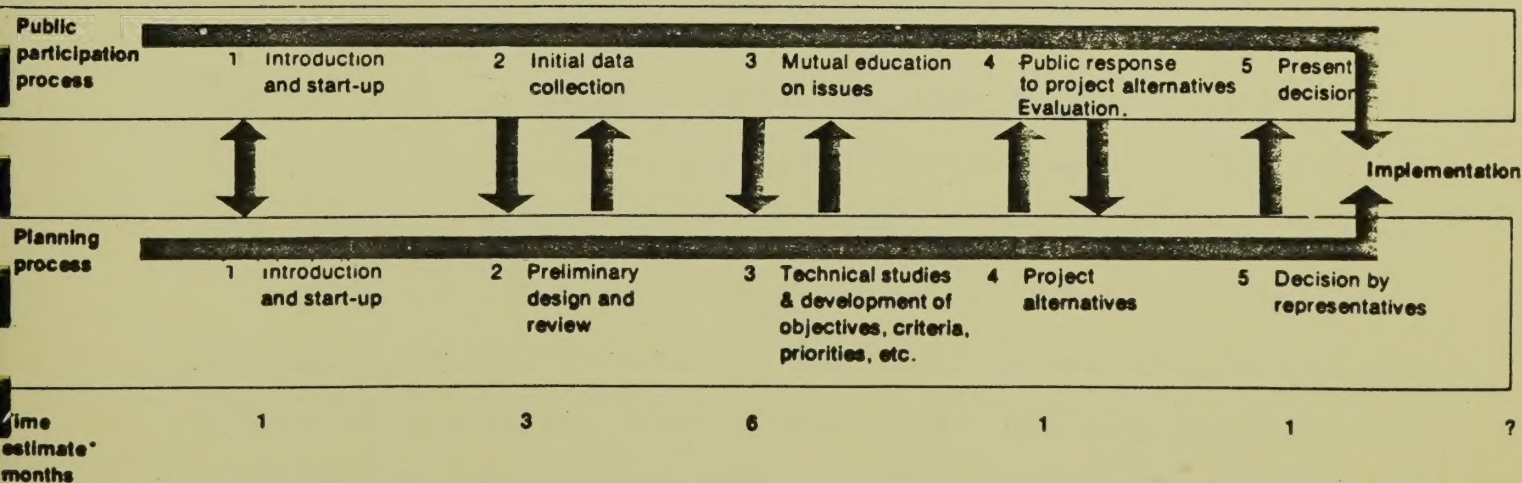
Conclusion

This outline has indicated some elements in the nature, rationale, program staff and budget estimates for a public participation program.

The techniques described here were tried with success; they must be adapted to the specific circumstances of each project.

D.M. Connor

Public participation in the planning process



Based on a one year planning process



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August 29th, 1980

SUBMISSION TO: THE CORPORATION OF THE CITY OF HAMILTON

SUBMITTED BY: ONTARIO PUBLIC INTEREST RESEARCH GROUP
HAMILTON

FOR: HAMILTON ENVIRONMENT '80 CONFERENCE

SUBJECT OF PAPER: INDUSTRIAL WASTE AND ITS DISPOSAL IN THE
HAMILTON AREA

INTRODUCTION

The Ontario Public Interest Research Group initiated and undertook a summer research project with three student researchers on the issue of the disposal of industrial waste, particularly toxic chemicals. General concerns around waste disposal were examined with emphasis on the local scene in Hamilton-Wentworth. Although the project officially ended on August 29th, the Ontario Public Interest Research Group is continuing its focus on industrial waste disposal. The project was federally funded under the Summer Youth Employment Program.

Data and information were collected from a wide variety of sources including government, industry, independent researchers, community groups and library documents. The many contacts made with people involved in waste disposal revealed a concern and sense of urgency in dealing with increasing stockpiles of industrial waste, especially toxic liquid waste.

ONTARIO PUBLIC INTEREST RESEARCH GROUP

One of the educational releases which the summer project produced was a slide tape show which we will now present.

COMMENCEMENT OF SLIDE TAPE SHOW

Industry - it is an important part of our society. It provides us with jobs and with material goods that are useful and enjoyable. But we often run great risks to obtain these benefits, for industry may also create potential hazards to human health and to our natural environment.

Chemicals are an indispensable part of the industrial process. In Hamilton, steelmaking requires calcium cyanamide, coal tar products, and many other poisonous chemical compounds. Benzene and barium are vital to the manufacture of certain soaps and detergents. Phenols, amines, and organic solvents all play a part in textile manufacture.

Yet often, despite their usefulness, toxic industrial chemicals must be discarded as waste - dangerous waste. PCBs, used as an insulating agent in electrical transformers and household appliances, are non-biodegradable - they won't break down in the environment. When they enter the body through the stomach, lungs, or skin, PCBs are poisonous and carcinogenic. Contact with phenols, which aid the manufacture of such common goods as perfume and paint remover, may result in a simple headache, but could also lead to death. Some waste chemicals have immediate effects causing skin rashes or breathing problems. Others accumulate in the human body, and after long-term exposure, declare their presence in the form of disease or cancer.

More than 63,000 man-made chemicals are now in use, and that number¹ is increasing at a rate of about 1,000 a year. If our industries continue to produce and use large quantities of toxic chemicals, we must find safe methods of disposing of them after they have served their purpose.

Canadian biochemists Ross Hall and Donald Chant write: "The ultimate fate of every compound is to be discharged...into the air, the water, or onto the land, where singly or in combination, they alter the environment".² The disposal of toxic chemical compounds should provide double protection. Chemical waste should be confined, so that it cannot escape into the environment. And it should be kept as far as possible from areas of human habitation. Accidental spills, leaks, leaching, evaporation - all of these results of human error could cause people nearby to be exposed to hazardous chemicals. Unlovely to look at, unhealthy to touch -- toxic chemical waste just isn't a good neighbour.

But let's not be deceived. "Out of sight, out of mind" is an attitude we cannot afford to take. One Ontario newspaper tells of 800 forgotten dumpsites that have been tracked down in this province alone - contents unknown. Before 1971, no industry, disposal firm or government agency was obligated to keep a record of toxic waste disposal sites. Much untreated waste found its way into open dumps and landfills designed for household garbage. A closer look at landfilling will show that ignoring the fate of toxic waste does not make the problem go away. On the contrary, it increases the hazard.

A landfill, as its name implies, is a large hole in the ground destined to be filled with household, commercial, and industrial garbage. Most of this refuse is solid and non-toxic. It is dumped, spread and covered with dirt or some other fill material, layer upon layer. When full, a sanitary landfill site may be converted to an open park or sports field. It certainly looks sanitary from the outside, but... what's happening on the inside?

Methane, formed by the decomposition of garbage, must escape upwards from the dump through vents. If no vents are provided, this non-toxic but flammable gas may migrate laterally, presenting residents nearby with the threat of basement explosions. Liquid from the buried refuse, combining with rainwater and underground moisture, may seep out of the landfill to be carried by underground waterways to neighbouring areas. If toxic liquids are landfilled, they will travel with this leachate, and may lodge in soil or enter the lakes which provide our drinking water. And while the water purification process can remove solids and bacteria, it cannot deal with non-biodegradable toxic wastes like PCB's and heavy metals. Through the fish we eat and the water we drink, small amounts of these poisons find their way to their final home - the human body.

How can this deadly pathway be broken? Improved landfill design is one solution. In a secure landfill, a clay liner should minimize leaching. Leachate may be monitored, collected and treated. Careful records should be made of incoming hazardous wastes, and, after the site is closed, a permanent record of its location and contents should be registered. In this way, we can save future generations from nasty surprises, and from needless Love Canal-type tragedy.

Theory and practice have shown that it is possible to change the composition of toxic waste by chemical treatment. For example, some waste chemicals can be mixed in large pools with a reactant such as lime. The chemical reaction which follows binds them into a solid rock or plastic-like material. Other methods include carbon adsorption where activated charcoal exchanges molecules with the

waste passing through it; and biological oxidation, where microbes produce oxygen which gives electrons to the waste substance, thus changing its chemical and physical nature.

Incineration is another promising method of liquid waste disposal. With proper control equipment, the wastes are generally transformed into harmless products of combustion, like carbon dioxide and inert ash. PCB's for example, are destroyed at 3,000 degrees celsius, and can be safely incinerated in a cement kiln.

Yet even these comparatively safe methods of waste disposal are not ideal. They still produce solid waste which must be landfilled, or gases which escape into the atmosphere. Why couldn't one man's garbage be another man's goldmine? To increase the efficiency of the entire waste disposal effort, one industry's waste could become another's raw material. By recycling, re-using or exchanging discarded chemicals, industries can decrease the volume of chemical waste which must enter the environment. Increased recycling might also mean that the volume of toxics now produced could be diminished. Less chemicals produced and more recycling would mean fewer chemicals discarded, and less hazard to the environment.

Recycling and re-use, chemical and thermal neutralization, secure well-monitored landfill sites. In combination, these could provide a safe and economical way of dealing with toxic liquid industrial waste. How does reality measure up to this ideal situation?

The Upper Ottawa Street Landfill has been in operation for twenty years. It has no clay liner, nor a mechanism for leachate control -- yet it has been a principal disposal facility for

hazardous waste. The landfill is located in a heavily populated urban area. Near the oldest section of the landfill, a black tarry substance oozes from lawns. At night and during rainy weather, residents complain of an acrid chemical odour. Local residents have documented their health problems: earaches and nosebleeds are common, and they attribute more serious illnesses to the leaching of toxic substances.

"...There was a high incidence of skin rashes, colds, kidney problems, sore throats and bleeding -- a lot of abnormal bleeding amongst the children, nosebleeds...I also started to go amongst some of the people who lived in the area for longer than five years and the results were frightening, the problems were much more serious - cancer, epilepsy, nervous breakdowns, bone problems, it was just like out of the Love Canal." 3

On July 14, 1980, the Upper Ottawa Street Landfill was closed to the public. It is filled to capacity; all dumping of both ordinary garbage and chemical waste must cease. A pressing question follows: What will be the fate of the toxic liquids that can no longer be dumped at this site?

A new site in Glanbrook has been slated to receive the Region's municipal garbage during the next two decades. Unlike the Upper Ottawa site, the Glanbrook site will be clay lined, with a mechanism for leachate collection and, according to the politicians and engineers who designed it, it will not receive toxic industrial waste. Dumping chemicals into the Glanbrook site may be the easiest solution to the disposal problem, but it would also be the least responsible.

The Glanbrook site, located on prime farmland, is sandwiched between the Buckhorn and Chippewa Creeks. Part of the site is on

a floodplain; part has been designated environmentally sensitive, and is the home of rare flowers and migratory birds. The Binbrook Anti-Dump Group is concerned about the effect that leachate may have on the farmland in the area, and on the watertable that feeds many other farming communities in the Niagara peninsula. They also fear that the floodplain area, valuable to botanists and to area historians will be damaged or destroyed. For these reasons, toxic chemicals must certainly avoid the Glanbrook site.

Until recently, Ontario lessened its toxic burden by exporting certain wastes to the United States. But in January of 1979, the U.S. government closed the border to shipments of liquid PCB wastes and May 1980 will see even tougher border regulations. Clearly, our reliance on American charity must end.

Further, long distance transport itself involves hazards. Drivers should understand the dangers involved in toxic waste handling, and should be trained to deal with accidents. Vehicles should have regular safety checks, and transport routes should avoid residential and urban areas. Border restrictions and transportation risks both support a single conclusion: Ontario will have to take responsibility for the nine million gallons of hazardous liquids that it generates each year.

Another non-solution is storage, for stored wastes must eventually be dealt with permanently. Once again, the "out of sight, out of mind" attitude fails to provide any real answers. Consider the case of a local firm which handles PCB's. While their contaminated solids - earth, clothing, machinery - can be

exported, their liquids cannot cross the border. Although a cement kiln suitable as a burning site exists in Mississauga, the municipal council has forbidden its use, and no other method of PCB treatment or disposal is legal in Ontario at this time. Gallons of untreated waste, amassed in warehouses and storage tanks -- this stop-gap remedy is surely as unsafe as it is unsightly.

A variation on the storage and landfill theme is deep well injection. This method involves pumping waste 860 meters below the earth's surface. There, the waste disperses into porous Cambrian rock, polluting it with a thin widespread layer of toxic liquid. Certainly, it is out of sight - but for how long? Couldn't a fault in the rock or a mild earthquake cause the chemicals to escape into the watertable? How will injection affect wells and farmland? Unanswered questions plague this method and make its use unwise.

The flaws of export, storage and landfilling point to an urgent need. We need to develop and use safe disposal methods, and we need to do it now. In the toxic waste disposal issue, there can be no opponents; government, industry and the public must work together to safeguard human health and environmental well-being.

Governments should act as watchdogs, providing tough but realistic legislation. The government of Ontario, for example, has yet to prohibit the disposal of all untreated liquid wastes into landfill sites, a fact which may allow industries and disposal firms to put the environment at risk legally. Governments should also take care to enforce and follow their own guidelines. When the region of Hamilton-Wentworth chose the Glanbrook landfill site,

it clearly disregarded guidelines submitted to the Ministry of the Environment which state that landfills should not be located in Grade 1 or 2 farmland, nor in environmentally sensitive areas.

Government and industry could collaborate to fund truly independent research into safe, long-term disposal methods. As the principal creator of toxic liquid wastes, industry could invest in recycling technology, and develop safe replacements for the toxic chemicals it uses and discards. Industries can increase their responsibility for the wastes they generate by monitoring the waste disposal companies that they contract, and by refusing to deal with firms which disobey Ministry regulations and guidelines.

As individuals and as community members who have an obvious stake in our health and in the welfare of our natural surroundings, we cannot trust in "leaving it to the experts". We ourselves must become informed about toxic waste disposal issues that affect our communities. First, become aware of disposal facilities in your area, and arrange to see them in action by touring them with a staff member. Ask questions and insist on answers. Where waste disposal strategy is concerned, we should not be kept in the dark. In many cases, our tax dollars support waste disposal facilities. Locate former disposal sites and find out how they have been dealt with since their closure. Are they well marked as former disposal sites? Is their content known? Are they being safely reclaimed? Landfills, for example, are often successfully converted to open parks or sports field. In Hamilton, the West End Landfill is now undergoing such a transformation. And, although users of the new park might never suspect that garbage forms its foundation, this information must

not be ignored. Explosive methane, formed by the decomposition of organic waste, must escape upwards. If buildings are erected on the site, the trapped gas may explode. Further, what goes up tends to come down in Hamilton. The city is subject to temperature inversions, which cause rising gases to descend at night. If the park is used at night, any source of heat, from a spotlight to a cigarette could trigger an explosion.

Of course, few people want to live next door to a dump and no one enjoys the thought of having a hazardous waste disposal facility in their neighbourhood. Here, we must be realistic. Many methods of treatment are safe and should be permitted, for the alternatives are treacherous: storage, landfilling, or secret dumping. However, it sometimes seems that profit and convenience are the main motives for establishing a disposal site, and that concern for human health and ecology are low on the list of concerns. When this happens, community action may be necessary.

"I've read enough, I've met some people who have been contaminated, I know what happens when you feed your animals water that is not good, most of the time it is instant death. I just can't stand by idly and do nothing and see it happening when there is something we can do about it. There are safer ways to handle any kind of these chemicals. The politicians don't seem to be of a mind to do it because of political pressure, financial pressure. Sure, today maybe the cheapest way is to just throw it out the back door in a heap and forget about it and let future generations look after it, but I don't happen to think that it's the humane thing to do."

An effective community group will use many resources. A good starting point is the experience of others: read case studies, talk to other groups involved in waste disposal issues. Become familiar with the legislation that governs your issue. David Estrin's book Environment on Trial can help laypeople to grasp the legal aspects of

toxic waste controversies. Meet the politicians who play a role in your issue. Find out where they stand, and why. Publicise your case: introduce your group to local media, write letters, attend public functions like Ministry of the Environment open houses. Be persistent!

"Going into these hearings - we'd never been and now we've been, and we're not so frightened...Fear of the unknown - some of these other groups have that kind of experience - we didn't have any of that, but we've just gone ahead anyway and there just doesn't seem to be any turning us back! What we don't know, we're willing to learn".

End of Slide Tape Show

The slide tape show has presented to you the general industrial waste disposal situation, emphasizing the handling of liquid wastes both in Ontario and in Hamilton-Wentworth.

We would like now to continue our presentation with a description of the perpetual risk presented by toxic waste and a closer examination of the Hamilton picture with regard to industry's participation in setting the trend for existing and proposed facilities.

A recent episode which alerted people to the continuing threat of disaster due to inadequate disposal methods for industrial waste occurred in August of this year. Dioxin, a deadly byproduct of herbicides 2,4,5,-T and silvex was found to be 100 times greater in Niagara sewers than last year. Tests confirm that it is leaking from Love Canal and entering the Niagara River and Lake Ontario, which is the source of our drinking water. Dioxin can be toxic at levels of 5 parts per million; it attacks the body's immune system and alters DNA, the genetic information.

About 60 million gallons of liquid industrial waste is generated annually in Ontario and about 20 per cent of this is considered hazardous. This label covers waste that may be toxic, explosive, flammable volatile, radioactive or pathological and thus necessitates special precautions in its storage, collection, transport and disposal. Approximately one-half of this 60 million gallons is currently dumped untreated into 23 landfill sites, mostly in southern Ontario. In many cases, hazardous wastes are included.

The other 50 per cent of Ontario's liquid waste is disposed of in the following way: 20 million gallons are incinerated at the Tricil plant near Sarnia, 3 to 6 million gallons are shipped to the United States and 2 to 6 million gallons were solidified at the Hamilton plant before its closure in 1979.

Until about ten years ago, companies were allowed to sell and dispose of any chemical without regulation except for a few well-defined poisons and chemicals in food, drugs and pesticides. About 90 per cent of all manufactured chemicals did not fall into any regulated category until the Environmental Contaminants Act was passed in 1976. Thus, chemical production was often accompanied

by limited understanding or concern about its effects on environment or public health.

Starting from the standpoint that these chemicals are in production and are being utilized for some industrial or commercial purpose, the least we can reasonably expect is that their wastes are being safely disposed of by those industries and municipalities producing them. However, effective disposal methods are presently not an integral part of the production, use and management of these chemicals. These facts are acknowledged by both government and industry.

An examination of the past history of the Upper Ottawa Street landfill site in Hamilton reveals allegations of mismanagement that relate to such ineffective disposal methods.

The landfill was operated by Interflow Systems Ltd. and the solidification plant on its grounds was owned by KD Enterprises Ltd. Both Interflow and KD Enterprises are subsidiaries of Laidlaw Transportation Ltd., a Canadian corporation whose head office is in Hamilton. Laidlaw is engaged in waste management services, highway transport and passenger bus and taxi service with major subsidiaries throughout Canada.

In 1978, 138 charges were laid against employees of Interflow and KD Enterprises for providing false information to the Ministry of the Environment and for improperly filling out shipping records; it was alleged that waste was dumped untreated into the Hamilton Harbour. All 138 charges were dismissed on a technicality. The Ministry's Certificate of Approval to Interflow had stipulated that only waste generated in Hamilton could go into the solidification process. However, an official of the Ministry stated that less than one per cent of wastes taken by Interflow to the plant

at Upper Ottawa Street was generated in the Hamilton-Wentworth region. By March 1979, Interflow Systems Ltd. was sold to Frontenac Chemical Waste Services Ltd., whose parent company is also Laidlaw Transportation Ltd. At the time of sale, Liberal Leader Stuart Smith stated that only one person was new in the newly-formed Company. Frontenac Chemical Waste Services Ltd. is currently active in Hamilton and operates a transfer site at the Hamilton Harbour to move chemical waste from Canada and the United States.

The Upper Ottawa Street landfill site was closed on July 14th, 1980 for public use. It will be completely closed to industrial use once the Glanbrook site opens. It will receive municipal, commercial, and industrial refuse; but, according to politicians and engineers, it will not accommodate toxic waste. The Glanbrook site is one component of the waste management program of Tricil Ltd.

All waste disposal facilities for the Region of Hamilton-Wentworth are now controlled by Tricil Ltd. The Region and Tricil entered into a ten-year contract valued at \$60 million that commenced in 1978. Tricil operates the entire disposal system that includes: incineration at SWARU (Solid Waste Reduction Unit) in East Hamilton, three waste transfer stations and a bulk haul transportation system for waste from transfer stations to the landfill site. This landfill site in Glanbrook is intended to service the whole Region.

Tricil is jointly owned by Trimac Ltd. and Canadian Industries Ltd. Trimac is a Canadian-owned corporation with subsidiaries in the United States, United Kingdom and Nigeria. Canadian Industries Ltd. is a subsidiary of Imperial Chemical Industries Ltd. of the United

Kingdom. This U.K. parent company is a member of five worldwide consortia and has many subsidiaries including CIL Ammunition Ltd. and Continental Explosives Ltd. in South Africa.

Tricil Ltd. also operates the incineration plant near Sarnia but it can only handle about one-third of the total 60 million gallons of liquid waste. To help alleviate this problem of lack of adequate facilities, two solidification plants have been proposed that have been endorsed by the Ministry of the Environment. The Ministry has promised to underwrite costs of environmental hearings for the two firms involved up to a maximum of \$100,000 if approval is not granted.

One solidification plant has been proposed for Harwich Township by Browning-Ferris Industries Ltd., a multinational corporation with sales of \$312 million annually. Browning-Ferris also owns many of Metro Toronto's solid waste hauling companies. This corporation is engaged mostly in the collection, processing, recovery and disposal of solid and liquid wastes, including hazardous waste.

The second plant has been proposed for St. Catharines by Walker Brothers Ltd. They are a subsidiary of the SCM Corporation of the United States which manufactures chemicals, paints, paper and pulp, typewriters and other equipment. SCM has 38 subsidiaries around the world with an annual sales volume of \$1,200 million. An elite one per cent of American business controls over two-thirds of the United States sales volume. Both Browning-Ferris and SCM Corporation are members of this elite.

More detailed information about companies involved in waste disposal can be obtained from the OPIRG office in its corporate profile publication.

As insurance against environmental threats in the future, it can only be hoped that these companies will construct technologically sound and carefully monitored plants that will dispose of liquid waste while guaranteeing minimal hazards to our natural surroundings and public health.

The Ontario Public Interest Research Group would like to express its thanks to the City of Hamilton for giving us this opportunity to present our research on waste disposal. We hope that this presentation has increased your understanding of the issue and has conveyed the urgent need for adequate disposal facilities.

THE END

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THE MANAGEMENT OF WASTE MATERIALS AT DOFASCO

by

PAGE

W.R. ROMBOUGH

DOFASCO

A Paper to be Presented
at a Conference on

"A Quarter Century of Environmental Progress
in the Hamilton Area and
a Blueprint for the Future"

MOHAWK COLLEGE

November 14th 15th, 1980

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INTRODUCTION

Dofasco in Hamilton is Canada's second largest steel maker, providing over 20% of this country's domestic steel production. It is a fully integrated company producing a variety of flat rolled steel products and steel castings.

Last year, Dofasco produced four million ingot tons of steel with a work force of over 11,000 employees. To produce this steel, over 9.2 million tons* of purchased raw material was brought into the plant and in addition to this, we used, cleaned and returned nearly 40 billion gallons of bay water and used 350 billion cubic feet (or nearly 14 million tons) of air for combustion. * (See Table 1)

Naturally, in such an enormous undertaking, large quantities of unwanted by-products are generated throughout the process from coke making to the finished steel. Dofasco must treat and/or dispose of about 450,000 tons of solid wastes and six million gallons of liquid and sludgy wastes each year.

INPUT OF RAW MATERIALS

MATERIAL FOR PRODUCTION OF FOUR MILLION INGOT TONS	QUANTITY TONS/YEAR
Iron ore	5,050,000
Coal	2,275,000
Oxygen	474,000
Oil	450,000
Limestone and Dolomite	340,000
Lime	300,000
Natural Gas	52,000
Atmosphere gas (HNX)	50,000
Foundry sand	44,000
Plating and coating materials	32,000
Steelmaking additives	27,000
Blast furnace runner sand/clay	25,000
Desulphurization reagents	20,000
Refractories	15,000
Total	9,154,000
Water useage (Baywater plus city water)	194,000,000 (38.7 X 10 ⁹ gal.)
Air useage (Combustion air plus Blast furnace wind)	20,000,000 (5.48 X 10 ⁸ MCF)

Table 1

Since the great majority of the raw materials are natural minerals -- iron ore, coal and limestone -- the solid wastes produced from these are generally non-hazardous and any problems which arise are due more to their physical characteristics than their chemical or toxic properties.

LIQUID WASTES

The disposal of liquid wastes has generated much controversy and publicity in recent years. Because of a few highly publicized problems, the term "liquid industrial waste" has become an emotional trigger even though most wastes are nuisances rather than hazards.

Many studies have been made and ideas voiced, but the only area of agreement is that the existing system, or lack of a system, of liquid waste disposal is not acceptable.

It is even more unacceptable to have no system for disposal and, simply passing a by-law to ban liquid wastes will not make them go away. Unless Canada is to go back to the "hewers of wood and drawers of water" economy, it is imperative that the public, industry and government co-operate to work out a satisfactory method.

A proper technical attitude and control system must be developed to deal with liquid waste treatment and disposal. It should, however, be recognized that even the best technical solution is worthless if every community forbids the construction and operation of waste treatment plants. This is the stage we are now in.

The first step in developing an effective waste management system is to identify all the types, sources and quantities of waste generated. Dofasco has catalogued all wastes and continually updates these records.

The knowledge of how and why individual wastes are generated is vital information. Reduction or elimination of certain wastes benefits both waste management and productivity. This is the philosophy of Dofasco's waste management system. However, in an industry as well established as the steel industry, there are few new gains to be made by this approach which are technically feasible or economically viable.

A number of options are available for the disposal of liquid wastes. Recycling waste in plant processes is the first option evaluated. If in-plant recycle is not possible, other potential markets are investigated. In some cases, processing of the wastes is required in order to convert them into useable materials. The cost of this processing must be balanced against the cost of disposal. Table 2 lists a number of the useable materials currently being recycled at Dofasco.

MAJOR AREAS OF RECYCLING AT
DOFASCO

MATERIAL	DISPOSITION	QUANTITY TONS/YEAR
Blast furnace gas	Energy used by various production areas	9,300,000
Blast furnace slag	Sold	715,000
HCl acid (18%)	Reused in pickling operation	597,000
Steelmaking slag	Reused in blast furnace or sold	461,000
Coke oven gas	Energy used by various production areas	400,000
Mill scale	Reused in blast furnace	86,000
Coke breeze	Reused in coke ovens	80,000
Tar	Sold	63,000
Light oil	Sold	14,000
Recovered oil	Reused as fuel or as a dust suppressent on roads and coal piles	7,200
Acid regeneration iron oxide	Sold	10,000
Ammonium sulfate	Sold	7,000
Ammonia	Sold	2,000

Table 2

Despite continuing efforts to recycle liquid wastes and the rapid advances in waste treatment technology, there will always be some which require disposal. It is the responsibility of both industry and government to select and implement the most effective treatment and disposal option. The basis of this decision must be based on a balance between the environmental impact and the economics of disposal.

This paper will outline some case histories of Dofasco's efforts to improve our waste treatment technology. These efforts and future efforts will continue to emphasize the upgrading of wastes into useful or saleable materials.

DOFASCO OIL CONSUMPTION HOT MILL AND COLD MILL AREAS	
TYPE OIL	QUANTITY
Picking Oil	1570
Lubricating Oil	540
Hydraulic Oil	685
Grease	450

Table 3

OILY WASTE TREATMENT

Over 7,000 tons of rolling oils, pickling oils, lubricating oils, hydraulic oils and greases are consumed yearly in the hot and cold mill areas. (See Table 3)

DOFASCO OIL CONSUMPTION HOT MILL AND COLD MILL AREAS

TYPE OIL	QUANTITY T/YR.
Rolling Oil	5330 (1,200,000 gal.)
Pickling Oil	1570
Lubricating Oil	540
Hydraulic Oil	685
Grease	450

Table 3

Rolling oils are mixed with water to form emulsions and are used as a lubricant and coolant in the cold rolling process. The emulsions will eventually deteriorate and become contaminated and must be replaced. Continuous blow down and periodic dumps from the emulsion coolant system generate an average of 140 GPM of 2% oil in water emulsion. This effluent stream is treated in an oil removal system designed to break the emulsion and separate the oil from the water. Most of the emulsions are pumped directly from the mill areas into two heated storage tanks (100,000 gallons total). Some emulsions (13,000 Gal/Mon) are trucked to the collection centre since they are not directly linked to the storage tanks.

The hot emulsions (200°F) are pumped in 12,000 gallon batches to one of two separating tanks. Sulphuric acid is added to lower the pH to 1. The tank contents are mixed, then allowed to settle. The acid breaks the chemical bonding of the emulsifiers and allows the oil to float to the surface of the tank. After half an hour, most of the oil has floated to the surface of the tank as a 50/50 oil water mixture. This oily layer is drained into an oil neutralization tank. In the oil neutralization tank, caustic is added to raise the pH to 5.5. Once neutralized, the oil is then pumped to a storage tank. The acidic

water left in the separating tank contains some solids and trace amounts of oil. This is pumped to the neutralization and solids removal system for treatment and discharged to the sewer. (See Figure 1)

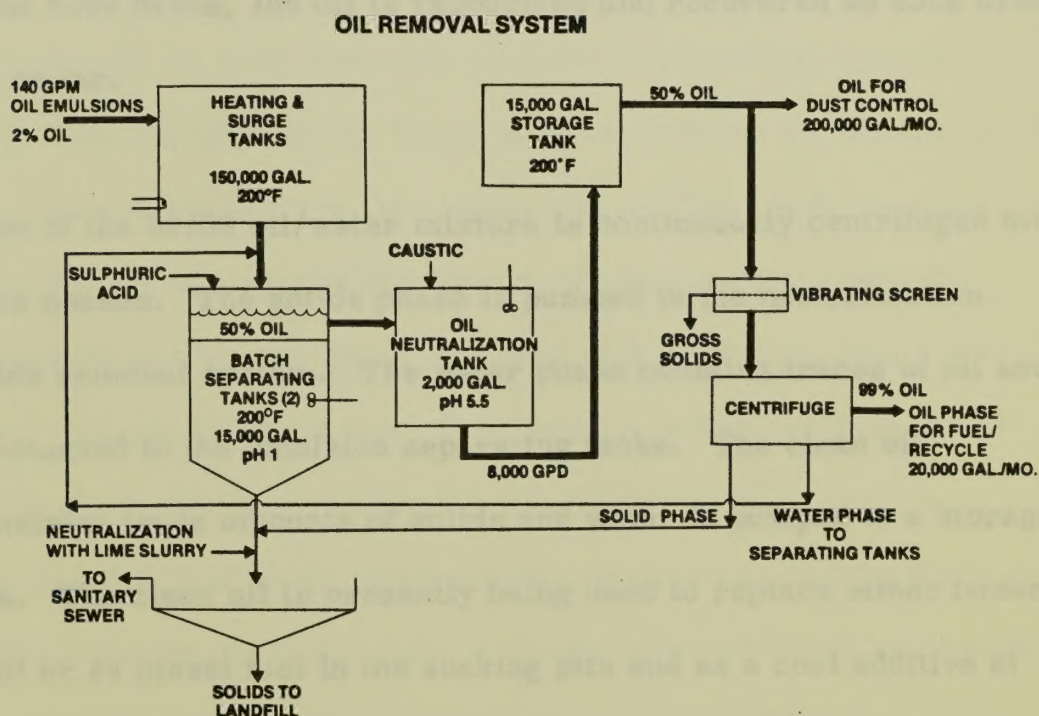


Figure 1

The neutralized oil can either be used directly as a 50% oil/water mixture or can be processed through a centrifuge for drying. The 50/50 oil/water mix is an ideal dust suppressant for the coal piles, gravel roads and ingot and coil yards. Extensive testing of commercial dust suppressants and crusting agents has found nothing to match the effectiveness or durability of the oil/water mix.

Tanker trucks, using gravity feed spreader bars or pump sprayers, apply over 200,000 gal/month to these areas.

In addition to solving the dust problem, the heating value of the oil applied to the coal piles is recovered in the coke making operation. In the coke ovens, the oil is vapourized and recovered as coke oven gas or tar.

Some of the 50/50 oil/water mixture is continuously centrifuged into three phases. The solids phase is pumped to the neutralization solids removal system. The water phase contains traces of oil and is returned to the emulsion separating tanks. The clean oil containing trace amounts of solids and water is pumped to a storage tank. The clean oil is presently being used to replace either bunker C oil or #4 diesel fuel in the soaking pits and as a coal additive at the coke plants. Tests are being carried out to re-blend the centrifuged oil as a rolling fluid.

FLUSHING LIQUOR AMMONIA RECOVERY

A weak ammonia liquor is produced in the collecting mains of the coke ovens by spraying water on the hot gases leaving the ovens.

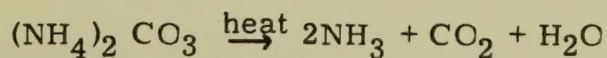
The spraying action not only cools the gases and condenses the tar, but also causes the water to pick up some of the ammonia in the gases as well as some hydrogen sulphide and hydrogen cyanide.

Most of the ammonia in the liquor is in the form of ammonium salts.

From the collecting main, the liquor and tar flows with the oven gases through the cross-over main to the downcomer where they are separated from the gases and then to the decanter tank where the tar and sludge settle out. The liquor is drawn continuously off the top of the tar, and recycled to the collecting main sprays.

Because additional water is constantly added to the system from the moisture driven out of the coal, a steady bleed-off must be maintained to control the level in the decanter tanks. This bleed-off is pumped to a holding tank prior to removal of the ammonia. (See Figure 2)

A portion of the ammonia in the liquor is present as ammonium hydroxide, but most is in the form of dissolved ammonium salts, of which there are two kinds: "Free" and "Fixed". "Free" salts are those decomposed by boiling, such as ammonium carbonate



AMMONIA LIQUOR FLOW

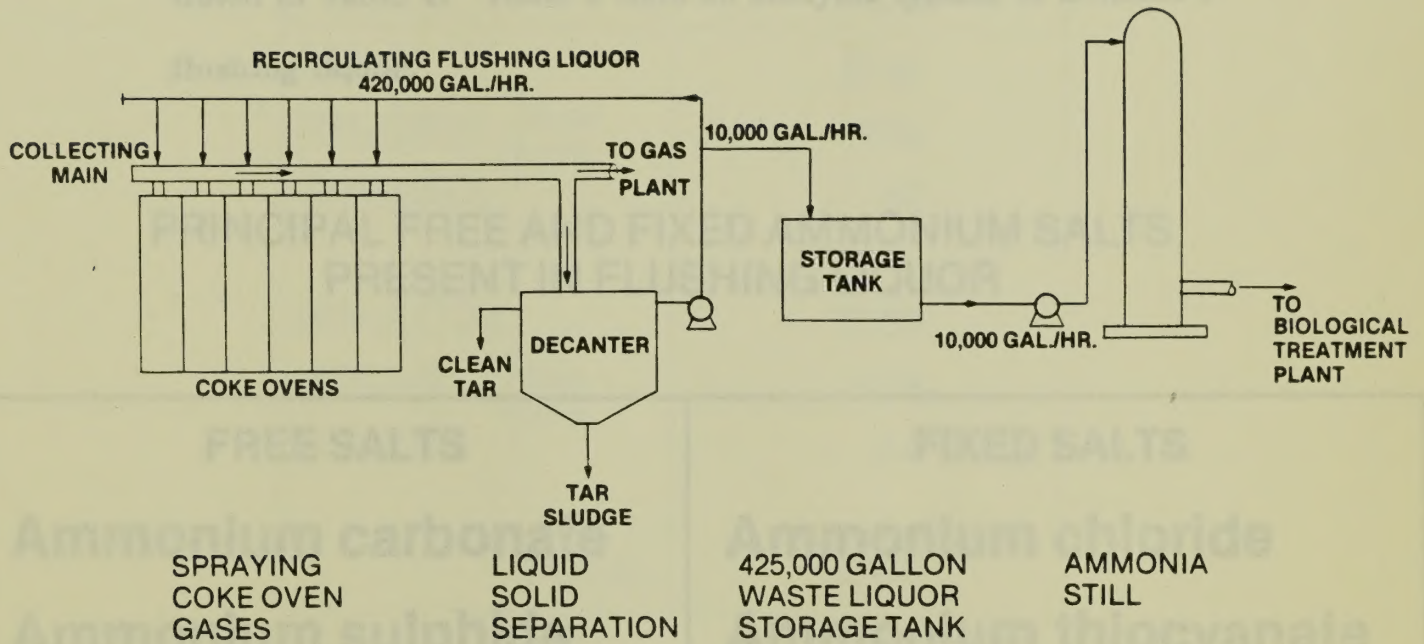
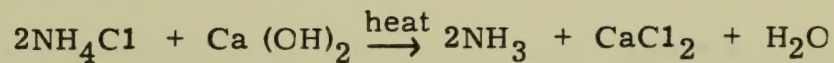


Figure 2

The products of decomposition are gaseous ammonia, carbon dioxide and water. The "Fixed" salts require an alkali, such as lime, to aid the decomposition:



The reaction products are gaseous ammonia and water vapour with calcium chloride as a dissolved salt.

The principal free and fixed salts present in a flushing liquor are listed in Table 4. Table 5 lists an analysis typical of Dofasco's flushing liquor.

PRINCIPAL FREE AND FIXED AMMONIUM SALTS PRESENT IN FLUSHING LIQUOR

FREE SALTS	FIXED SALTS
Ammonium carbonate	Ammonium chloride
Ammonium sulphide	Ammonium thiocyanate
Ammonium cyanide	Ammonium sulphate
Ammonium bicarbonate	Ammonium ferrocyanide
Ammonium bisulphide	Ammonium thiosulphate

Table 4

Because of the two types of dissolved salts in flushing liquor, a two part distillation column (still) is necessary to remove the ammonia. These two parts are called the "Free Leg" and the "Fixed" or "Lime Leg". In the free leg, the free ammonium salts are decomposed by direct steam and ammonia, hydrogen sulphide, carbon dioxide and hydrogen cyanide are driven off, together with

TYPICAL FLUSHING LIQUOR ANALYSIS

COMPONENT	CONCENTRATION IN TERMS OF NH ₃ mg/l
NH ₄ Cl	2248
NH ₄ CNS	100
(NH ₄) ₂ SO ₄	60
(NH ₄) ₂ CO ₃	1380
(NH ₄) ₂ S	148
NH ₄ CN	64
TOTAL	4000

Table 5

some organic matter present in the liquor. In the fixed leg, the fixed salts -- which are the largest proportion of the salts -- are decomposed. Slaked lime is added along with direct steam to the liquor in the "Fixed" leg of the still. (Reference 3)

The steam and gases from the still are injected into the hot coke oven gas coming from the ovens for cooling and recovery of ammonia.

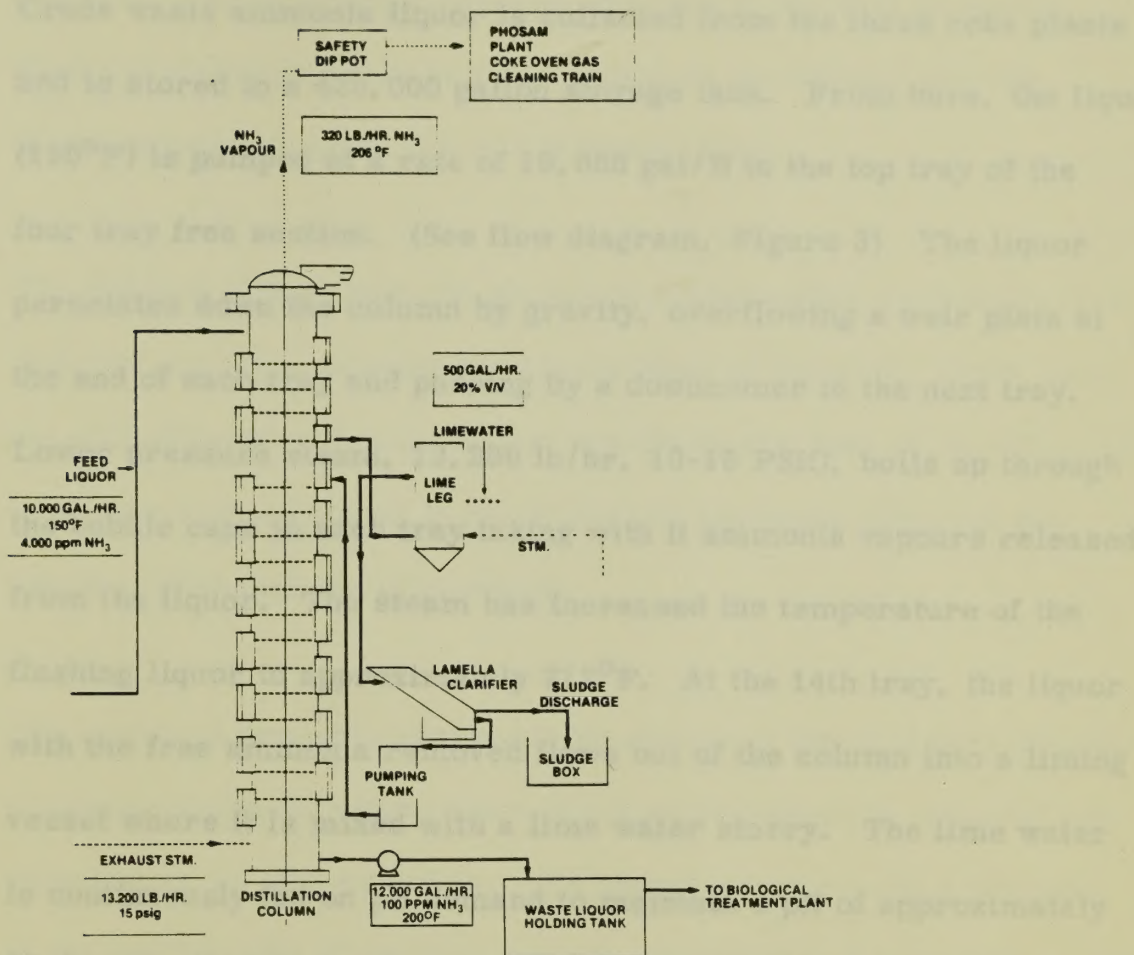


Figure 3

This distillation process is established technology and is used extensively in the steel industry. Currently 32 of the 51 North American steel plants use some form of ammonia distillation in the treatment of flushing liquor.

In 1971 Koppers installed Dofasco's first 17 tray ammonia still to treat the flushing liquor from the No. 1 and No. 2 coke plants. With the addition of No. 3 coke plant in 1978 a second identical ammonia still was installed to operate in parallel with the existing unit.

Crude waste ammonia liquor is collected from the three coke plants and is stored in a 425,000 gallon storage tank. From here, the liquor (150°F) is pumped at a rate of 10,000 gal/H to the top tray of the four tray free section. (See flow diagram, Figure 3) The liquor percolates down the column by gravity, overflowing a weir plate at the end of each tray and passing by a downcomer to the next tray. Lower pressure steam, 13,200 lb/hr, 10-15 PSIG, boils up through the bubble caps in each tray taking with it ammonia vapours released from the liquor. The steam has increased the temperature of the flushing liquor to approximately 212°F. At the 14th tray, the liquor with the free ammonia removed flows out of the column into a liming vessel where it is mixed with a lime water slurry. The lime water is continuously fed on pH demand to maintain a pH of approximately 10.5. The lime water is prepared in a batch slaker using a pug mill type wet slaker and a weigh belt feeder system. The limed liquor from the liming vessel flows into an inclined plate solids settler where the suspended solids level is reduced to below 100 mg/litre before being returned to the 13th tray; the top tray of the fixed section. The lime water reacts with the flushing liquor in the last 13 trays of the still releasing the fixed ammonia which is also carried up the column with the steam introduced under the still's bottom tray.

With the flushing liquor in the last 13 trays of the still releasing the fixed ammonia which is also carried up the column with the steam introduced under the still's bottom tray.

The flushing liquor, with the ammonia concentration reduced to less than 100 mg/litre, accumulates in the base of the still. From here, the still effluent or 'waste liquor' overflows at a rate of 12,000 gal/H to a sump and is pumped to the biological treatment plant for the removal of phenol and thiocyanate.

The overhead ammonia vapours from the top of the still pass through a partial condenser where some of the water vapour is removed and returned to the still as reflux. The vapour proceeds via a seal pot to the suction side of the coke oven gas exhausters for transfer to the cleaning plant.

Before 1978 ammonia recovery was not economically viable and the ammonia vapour was incinerated in a burner fueled with coke oven gas. In 1978, No. 3 coke plant came on stream featuring a phosam plant for anhydrous ammonia production. This plant now treats all the ammonia still vapour and half of the coke oven gas, yielding 2000 tons of anhydrous ammonia per year, which is consumed internally in the production of HN_x , a fuel gas.

ZIMPRO -- WET OXIDATION

Raw coke oven gas produced in the coke making operation contains ammonia (NH_3), hydrogen sulphide (H_2S) and hydrogen cyanide (HCN) as well as tar and light oils. These species are removed in the by-products plant before the gas is distributed as a fuel.

Hydrogen sulphide is removed from the gas by the Stretford process. The overall reaction involves the atmospheric oxidation of H_2S to elemental sulphur. Efficient HCN removal is essential to ensure the proper operation of the Stretford system. Any HCN which escapes the HCN scrubber is absorbed in the alkaline Stretford solution and reacts to form a compound which interferes with H_2S removal.

Hydrogen cyanide is removed in two packed counter-current scrubbing towers operated in series. The scrubbing liquor is a suspension of elemental sulphur in water. The reaction to remove the HCN occurs in two steps with the sulphur reacting with ammonia in the presence of H_2S to form ammonia polysulphide which in turn reacts with HCN to form ammonium thiocyanate, NH_4SCN .

A portion of the recirculating scrubbing liquor must be removed from the tower as blow down (10, 200 gal/D) and fresh reagents supplied to ensure NH_4SCN does not concentrate to the point where HCN removal from the gas is inhibited.

The treatment of this blow down has been the topic of extensive research at Dofasco since 1967. In all, some 28 different schemes to treat, incinerate, crystallize, solidify or recover this material have been investigated.

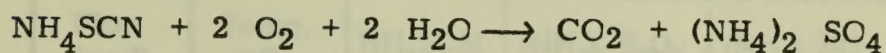
For one reason or another, these all had a failing which made the method impossible, inefficient, uneconomical, or unwise. Finally, a successful treatment process was found in the form of a very sophisticated, high temperature, high pressure wet oxidation system marketed under the name of Zimpro.

The process chemistry of Zimpro system can be broken down into a series of oxidation reactions.

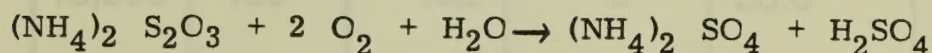
The effluent from the HCN scrubber consists of a water solution containing primarily ammonium thiocyanate and also other ammonium salts such as thiosulphate and sulphate, polysulphides, sulphides, and free sulphur in colloidal form. Most of the free sulphur is removed

by the centrifuge and the remaining stream is oxidized with air in the wet air oxidation unit where the following reactions occur:

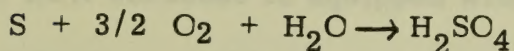
- a) Ammonium thiocyanate is converted to ammonium sulphate as shown below:



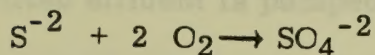
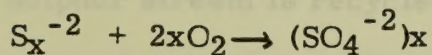
- b) Ammonium thiosulphate is converted to ammonium sulphate and sulphuric acid as shown below:



- c) All excess sulphur is converted to sulphuric acid as shown below:



- d) Polysulfide and sulfide ions are converted to sulphate ion as shown below:



- e) Other organics in the HCN scrubber effluent are converted to carbon dioxide and water.

The effectiveness of the process can be seen by the process feed and effluent analysis. (Table 6)

**TYPICAL FEED AND EFFLUENT ANALYSIS
ZIMPRO INC. DESIGN CONDITIONS**

	Flow (igpd)	Temp. (°F.)	NH ₄ SCN	Parameter Concentrations % by Weight			
				(NH ₄) ₂ S ₂ O ₃	(NH ₄) ₂ SO ₄	Susp. Solids	NH ₃ (free)
Feed to Wet-Oxidation System	10,200	70	20.9	2.0	.29	2.0	1.8
Effluent from reactor	10,600	150	.02	--	35.0	.02	--

Table 6

Each HCN scrubber is equipped with a constant rate blow down which feeds a solid bowl centrifuge where 90% of the suspended elemental sulphur is removed from the blow down stream to minimize oxygen demand. (See Figure 4 for the process flow diagram.)

The sulphur stream is recycled to the HCN scrubber. The clarified effluent is pumped to a 100,000 gallon storage tank designed to contain the effluent during shutdowns of the wet oxidation system for scheduled maintenance. Liquor from the storage tank and condensate from the wet air oxidation system are mixed at the suction side of high pressure pumps. The condensate flow rate is under ratio control to maintain the chemical oxygen demand in the

ZIMPRO — WET OXIDATION PLANT

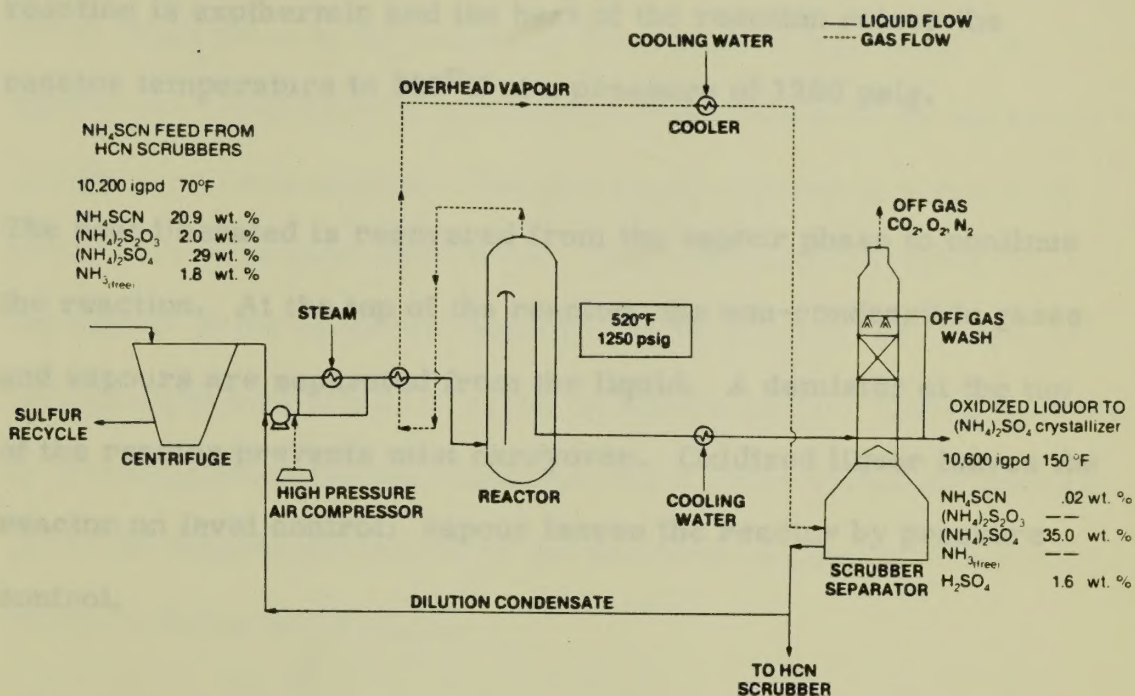


Figure 4

feed liquor at a constant 85 g/litre. High pressure pumps pressurize the feed to 1325 psig and the feed liquor is mixed with compressed air supplied by a remote four stage reciprocating compressor. The flow rate of air is adjusted to maintain 5% residual oxygen in the process off gas. The feed liquor-air mixture is heated to 375°F by indirect exchange with the hot gases leaving the top of the reactor. For process start-up, a separated high pressure steam heat exchanger has been provided.

The hot feed mixture enters the vertical titanium lined reactor and flows upward through mixing baffles. The reactor vessel has been sized to achieve the required oxidation of the ammonium salts and

sulphur feed at the peak hydraulic flow to the unit. The oxidation reaction is exothermic and the heat of the reaction raises the reactor temperature to 520°F at a pressure of 1250 psig.

The heat liberated is recovered from the vapour phase to continue the reaction. At the top of the reactor, the non-condensable gases and vapours are separated from the liquid. A demister at the top of the reactor prevents mist carryover. Oxidized liquor leaves the reactor on level control: vapour leaves the reactor by pressure control.

After the reactor, the non-condensable gases and vapour stream passes through the shell of the feed preheater, giving up heat to the incoming liquor-air mixture. Following the preheat step, the partially condensed vapour and non-condensable gas stream is indirectly cooled with bay water in the process cooler. The system pressure is then let down through a control valve and discharged under the condensate liquid level in the scrubber-separator.

The liquid product stream out of the reactor is first cooled against bay water in the brine cooler and then discharged into the scrubbing liquor storage compartment of the scrubber-separator.

The separation of non-condensable gases from the entrained liquid phase takes place in the bottom of the scrubber-separator. A condensate liquid level is maintained in the bottom of the separator-scrubber on level control. The gas-liquid mixture is discharged below the condensate liquid level. The condensate removed from the bottom of the scrubber separator is recycled to the suction of the high pressure pumps to serve as dilution water. During periods of insufficient condensate generation for dilution purposes, process water is added to the bottom of the scrubber-separator to ensure adequate dilute water supply.

The non-condensable gases passing upwards in the scrubber-separator are continuously scrubbed with the product ammonium sulphate-sulphuric acid solution. Any ammonia present in the off-gas combines with the sulphuric acid producing ammonium sulphate and thus eliminates ammonia discharge. (See Table 7) The cleaned gas is then vented to the atmosphere through a fiberglass stack.

The oxidized liquor, which is an ammonium sulphate solution (350 g/litre) (See Table 6) is sent to the ammonia sulphate crystallizer for recovery in conjunction with the stream from the ammonia absorbers. Approximately 18.5 tons of ammonia sulphate is recovered from the HCN blow down each day. This has almost doubled the

AIR CONTAMINANT LEVELS AND DISCHARGE RATES **ZIMPRO INC., DESIGN CONDITIONS**

	CONCENTRATION (PPM)	DISCHARGE RATE (gm/sec.)
Carbon Monoxide	314	0.226
Methane	5	0.002
Total Hydrocarbons	75	0.086
Cyanide as CN	<0.05	2.6×10^{-5}
Ammonia as NH₃*	<50	0.022
Sulphide as H₂S	0.03	2.6×10^{-5}

*** NOTE:** AMMONIA LEVELS ARE TAKEN FROM PILOT STUDIES WITH NO SCRUBBER.
 ACTUAL DISCHARGES ARE EXPECTED TO BE MUCH LOWER.

Table 7

ammonium sulphate production available for sale from 7,000 to 14,000 tons per year. Ammonium sulphate is used extensively as a fertilizer.

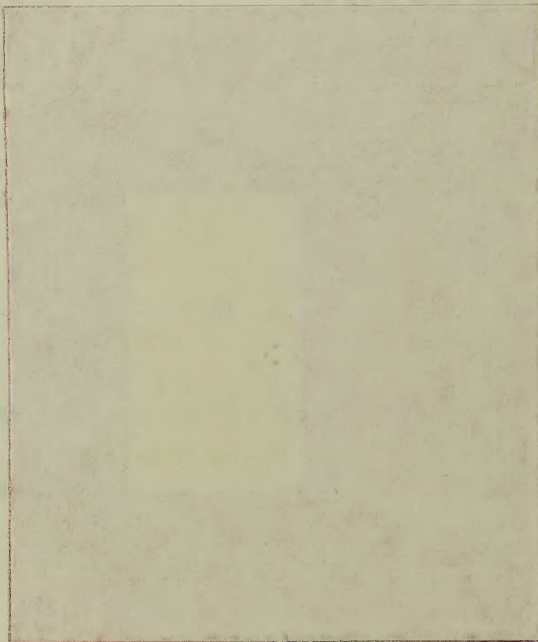
AIR CONTAMINANT LEVELS AND DISCHARGE RATES ZIMPRO INC., DESIGN CONDITIONS

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5	0.005	Methane
75	0.086	Total Hydrocarbons
<0.05	2.8×10^{-5}	Cyanide as CN
<50	0.023	Ammonia as NH ₃
8	2.8×10^{-5}	Sulphur

NOTE: A
A

Table 1

14,000 ton
a fertilizer
14,000 ton
is used extensively for
fertilizer



DISPOSAL OF TAR AND OILY SLUDGE

Tar is one of the saleable by-products derived from coke making.

The tar is driven off from the coal in the coke ovens. It is collected, condensed and separated from the water phase in tar decanters. In 1979 the 2,276,143 tons of coal charged into the coke ovens yielded 12,672,928 gallons of tar or 5.6 gallons of tar per ton of coal. In the processing, some of the tar becomes contaminated with solids, primarily coke fines and is unsuitable for sale. This sludge, approximately 45 tons per month, is separated and requires disposal.

The major source of oily sludges is from the cold mill operation.

Approximately 150 tons per month of this sludge is collected. Of this, 90 tons per month is generated as a result of the filtration of the rolling emulsion used as a lubricant and coolant for the rolling mills. The other 60 tons per month of this sludge is waste pickle oil. This oil consists primarily of animal fats and tallow and is spread on the steel coils as a rust inhibitor after the pickling operation. This oil, which drips from the coils during storage, is collected and requires disposal.

Many different options were examined in an effort to most efficiently dispose of these wastes. The utilization of the tar sludge as a roofing material and in asphalt mixes was studied. Also, experiments are being conducted in an effort to recycle the waste oil back to the rolling mills. The most promising method of disposal, however, appeared to be recycling the oils and tars to either the blast furnace or coke ovens. Bench scale mixes were made of these sludges with a variety of materials including limestone, slag, blast furnace dry dust, flue dust, coal and coke breeze. The optimum mix, chosen on the basis of mixing, handle-ability and ease of disposal, was a 7:1 mixture of coal and sludge to be charged into the coke ovens. Pilot testing was carried out using a Simpson Muller mixer. It was concluded the Muller mixer was a satisfactory piece of equipment for this application and work proceeded on a fullscale installation.

The mixing operation was set up at the #1 coke plant coal handling and is operated by coke plant personnel. A Simpson Muller mixer, size no. 3, was installed. (See Figure 5) The mixer consists of an 8' diameter circular pan 36" deep with a capacity of 25-30 ft³. Two large mullers or wheels sit vertically inside the pan hinged to a central vertical shaft by rocker arms. These wheels are 36" in diameter, 11" wide and weigh 2200 lbs. each. The mullers rotate horizontally around the central vertical shaft at 19-1/2 RPM. In addition to the

MULLER MIXER

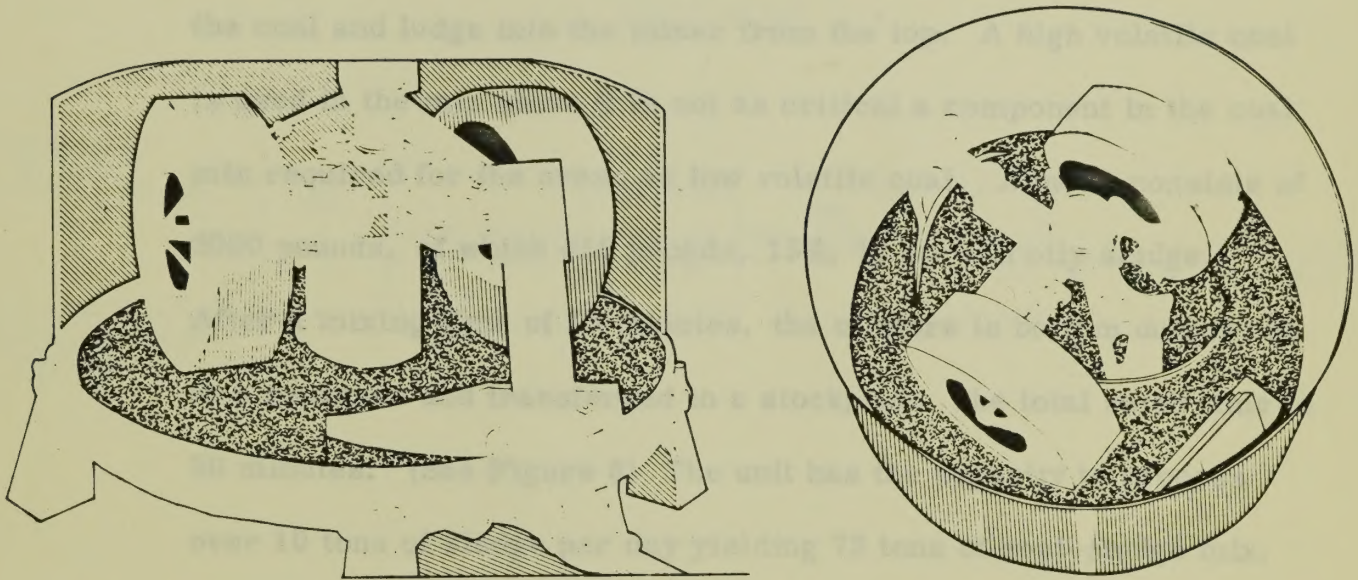


Figure 5

horizontal rotation in the pan, each muller is free to rotate on its own axle. The unit is powered by a 40 HP - 1200 RPM motor.

Adjustment of set screws maintains the mullers from $1/8''$ to $2''$ above the bottom of the pan, depending on the nature of the process and the materials to be mixed. The purpose of this arrangement is to provide mulling rather than grinding and to mix rather than pulverize.

Plows located both inside and outside of the mullers serve two functions. The first is to turn the material over and place it in front of the mullers for the twist and squeeze of the mulling action. The second, after the mulling, the bottom discharge door is opened and the plows automatically clear the mixer.

The mixing of the tar and oily sludges is a batch process. The sludges are collected from throughout the plant and stored in a containment bin located near the mixer. A front end loader places the coal and ludge into the mixer from the top. A high volatile coal is used in the mix since it is not as critical a component in the coal mix required for the ovens as low volatile coal. A batch consists of 3000 pounds, of which 450 pounds, 15%, is tar and oily sludge. After a mixing time of 15 minutes, the mixture is bottom dumped on to a conveyor and transferred to a stockpile. The total batch time is 30 minutes. (See Figure 6) The unit has the capacity to process over 10 tons of sludge per day yielding 72 tons of coal-sludge mix. The unit is currently handling 9.3 tons of sludge per day, five days per week and generating 62 tons of coal-sludge mix per day. The addition of the sludge and the mixing action increases the bulk density of the mix to 65 lbs/ft^3 . The usual bulk density of the coal charged to the ovens is 42 lbs/ft^3 . The coal sludge mix, therefore, is blended with other coals before charging into the ovens. This further dilutes the mix by a factor of 145. The ultimate coal to sludge ratio is approximately 1000 to 1. Because of this dilution, any contaminants present in the sludge such as iron or alkalis will not be significant. The coal-sludge mix does not cause equipment or processing problems in coal handling or charging.

TAR AND OILY SLUDGE DISPOSAL

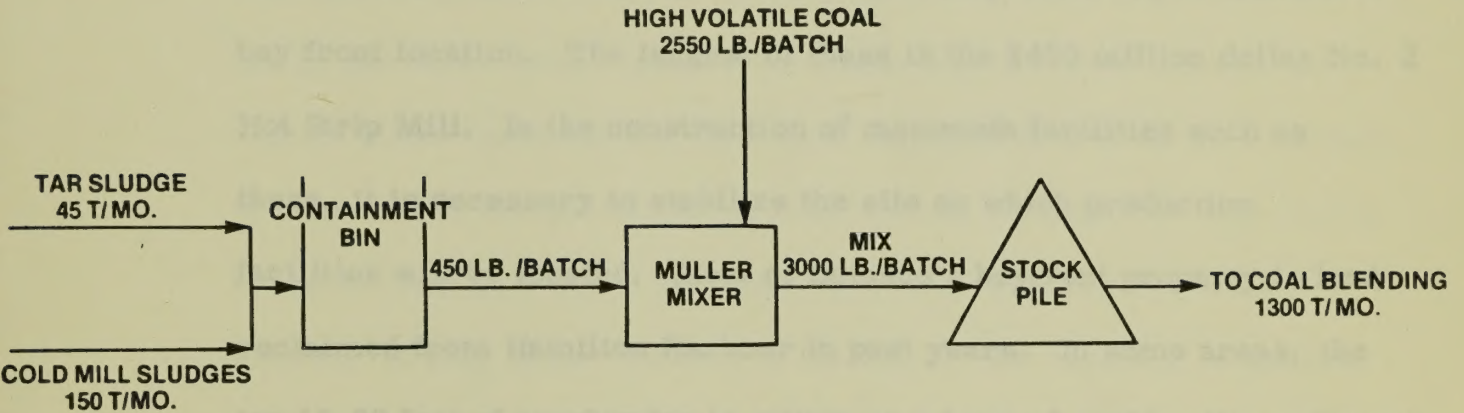


Figure 6

Once in the coke ovens, a small portion of the tars and oils will be converted into coke. Most of the tar and oil will vapourize. The tar will be condensed and collected as the tar by-product. The vapourized oil will remain in the coke oven gas and contribute to its heating value.

This is the first installation of its type anywhere.

INORGANIC SEDIMENT STABILIZATION

A number of expansion programs are currently underway at Dofasco's bay front location. The largest of these is the \$450 million dollar No. 2 Hot Strip Mill. In the construction of mammoth facilities such as these, it is necessary to stabilize the site on which production facilities will be located. Most of Dofasco's bayfront property is land reclaimed from Hamilton Harbour in past years. In some areas, the top 15-20 feet of overburden is sitting on a base of muddy silty sediment. In order to stabilize areas such as these, this sediment must be removed and replaced with rock. Although steel piles driven into the ground can provide the required support, a well stabilized soil will significantly reduce the number and size of the piles. In the case of #2 Melt Shop, some 4,000 12-inch pipe piles were driven about 70 feet into the ground.

Based on Dofasco's proposed expansion program, it was estimated that over 300,000 cubic yards of sediment had to be removed over a two year period. When clammed out the sediment contains 40-75% water. Although the sediment composition was suitable for landfilling, it was too sloppy to be acceptable.

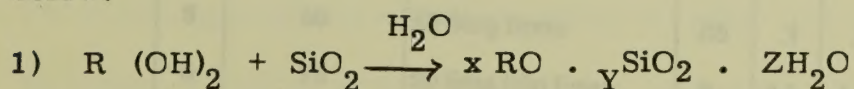
One possible solution was to mix the watery sediment with slag fines generated from our steelmaking operation. One part, by weight, sediment requires 2-1/2 parts, by weight, slag fines to produce an acceptable mix. There were two reasons why this solution was not viable. One, the amount of slag fines required to take up the moisture was more than our production of slag fines in the required time frame. It was estimated it would take six years to accumulate the needed quantity of slag fines. Second, a market for the resale of slag fines was in the process of being developed. The availability of the slag fines, therefore, was unsure and an alternative solution was required.

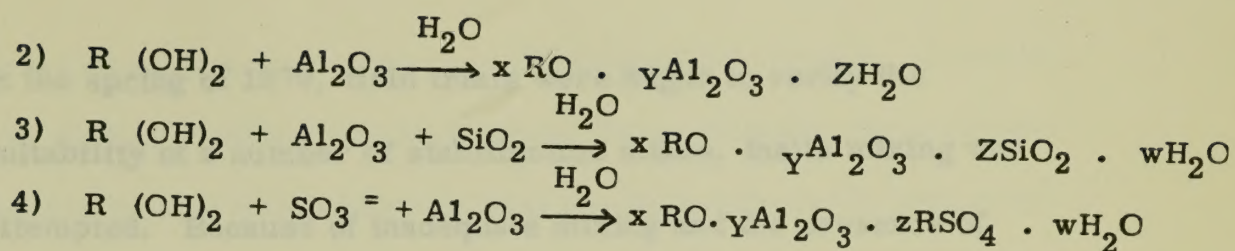
In 1978, Dofasco, with the co-operation of McMaster University, set out to find a method to stabilize the sediment. The specific objectives of the study were to identify a process which would:

- 1) Produce an aggregate with an unconfined compressive strength of at least $1.5 - 2.0 \text{ T/Ft}^2$ in a five to seven day period.
- 2) Produce an aggregate with an acceptable leachate quality.
- 3) Maintain the sediment component of the recipe greater than 75% of the mix.

Bench scale testing was set up to evaluate various stabilizing agents and addition rates. The agents evaluated were for the most part industrial waste materials generated by other industries. These included various lime kiln and cement kiln dusts, fly ash, and slag fines. In addition, slag cement and portland cement were tested.

Various combinations of sediment and stabilizing agents were mixed by hand in batches weighing 1500-2000 gm. The mix was placed in 10 cm diameter by 10 cm high containers, the twist lids put on, and then double sealed in plastic containers to maintain moisture conditions. Unconfined compressive strengths were tested at the time of mixing and after 1, 3, 5, 7, 14 and 21 days, using a torvane or penetrometer the stabilization process could be broken down into two stages. First, the free moisture content had to be reduced to allow rapid stabilization. Second, the additives must provide the basic ingredients to promote pozzolanic reactivity. The major cementing compounds formed by the pozzolanic reactions are calcium silicate hydrates and low sulfate sulfoaluminate. Some of the possible pozzolanic reactions are listed below:





(Reference 2)

NOTE: R = Ca ++ or Mg ++ or combination of these ions.

As a result of the laboratory scale testing, several potentially acceptable mixes were identified. Some typical results of unconfined compressive strengths are listed in table 8.

EXPERIMENTAL STABILIZATION—TYPICAL UNCONFINED
COMPRESSIVE STRENGTHS

No.	WT. % SEDIMENT (WET)	WT. % ADDITIVES	COMPRESSIVE STRENGTH T/FT. ²			
			1 DAY	3 DAY	7 DAY	14 DAY
1	85	10 lime kiln fines 5 Portland cement	.65	1.2	1.9	3.0
2	80	15 lime kiln fines 5 Slag cement	1.75	2.6	4.25	>4.5
3	80	15 Cement kiln dust 5 Portland cement	.15	.40	1.4	1.5
4	70	25 Fly ash 5 Slag cement	.03	.03	.1	.25
5	50	50 Slag fines	.05	.1	.2	.6
6	75	20 lime kiln fines 5 Portland cement	.9	>4.5	>4.5	>4.5
7	80	10 lime kiln fines 10 Fly ash	.8	1.1	1.4	1.65

Table 8

In the spring of 1979, field trials were begun to verify the suitability of a number of stabilization mixes. Insitu mixing was attempted. Because of inadequate mixing and the presence of excess surface water, a consistent stabilized mix could not be produced.

It was decided at this point that the sediment would have to be removed and processed in a stabilization plant. Trials using a grader to mix the sediment and additives verified adequate stabilization could be achieved if the ingredients were thoroughly mixed.

In the next series of field trials, a large hopper was constructed so that the sediment could be fed into a standard cement ready-mix truck using a three yard³ clam bucket. The stabilizing ingredients were added using a belt conveyor. After 5-10 minutes mixing in the cement truck enroute to the curing site, the mix was discharged. In some cases the sediment had to be stiffened to the extent where water addition was necessary to get the mix out of the truck. Several of the discharged mixes could be walked on after a few hours and, after 24 hours, could be driven over with a loader.

Field testing was conducted to verify laboratory results. A small area of the stabilized mix surface was removed when compressive strength testing was performed in order to eliminate the influence of surface drying. Typical results of unconfined compressive strength testing are listed in Table 9.

TYPICAL FIELD STABILIZATION TEST RESULTS UNCONFINED COMPRESSIVE STRENGTH

No.	WT. % SEDIMENT (WET)	WT. % ADDITIVES	COMPRESSIVE STRENGTH T/FT. ³			
			1 DAY	3 DAY	7 DAY	14 DAY
1	83.6	12.9 lime kiln fines 3.5 Portland cement	1.25	1.75	2.5	2.6
2	87.3	7.3 Lime kiln fines 5.4 Portland cement	.65	.7	1.25	2.1
3	75.0	16.0 Fly ash 9.0 lime kiln fines	.4	.5	.6	1.1
4	69.4	25.0 Fly ash 5.6 Portland cement	—	.3	.5	.6

Table 9

Based on these results, the optimum stabilized mix was determined to be 8-12% highly reactive lime kiln fines and 3-5% slag cement. The remainder was sediment. The variability was necessary to account for the fluctuations in water content.

The operation using the ready-mix cement trucks proved so efficient it was chosen for use in fullscale production. At peak operation, six 14 yd³ cement trucks can stabilize over 1100 tons of sediment in an 8 hour shift. Centralized additive storage silos have been installed consisting of one silo with a 200 ton capacity for lime fines, one with a 95 ton capacity for slag cement and a weigh batcher. Each batch consists of approximately 15 tons sediment and two tons additives. (See Figure 7) This plant has been in operation since April 1980.

The Ministry of the Environment unsaturated column leachate method, using distilled water, was used to evaluate leachate quality. Based on leachate data, approval has been received from the Ministry of the Environment to place the stabilized mix in a certified landfill site.

SEDIMENT STABILIZATION

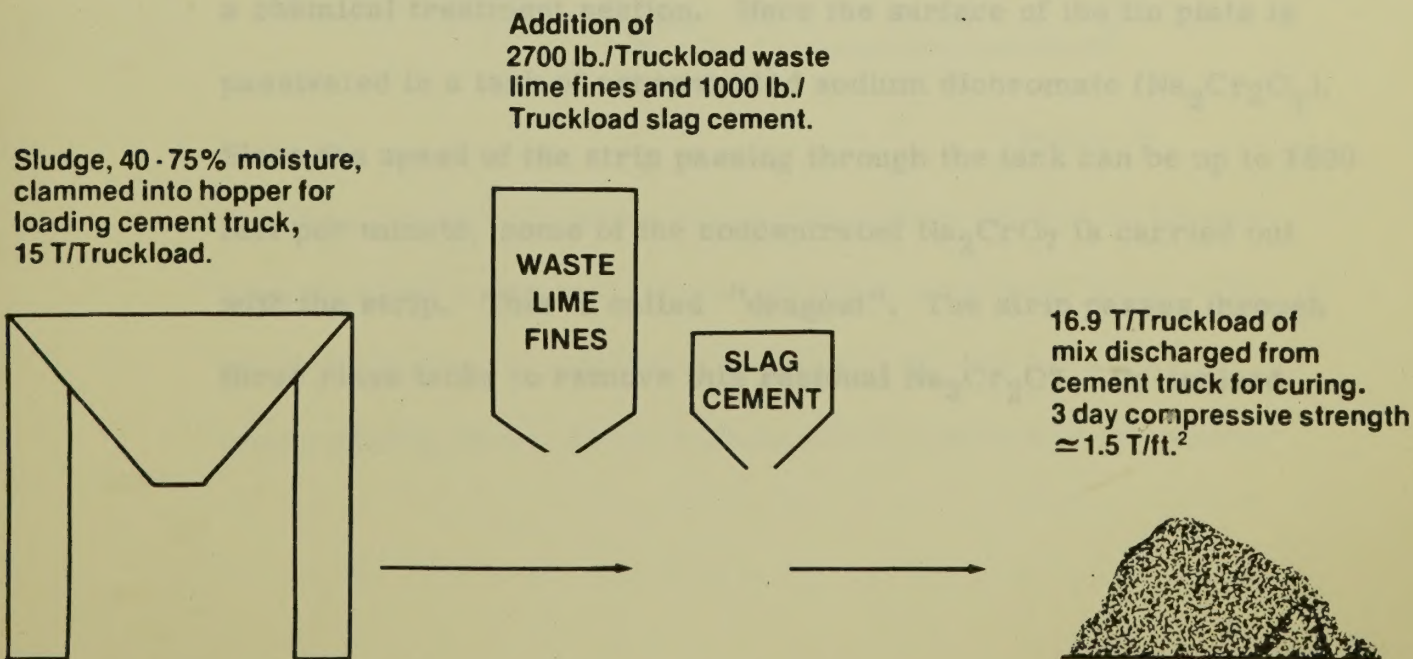


Figure 7

Recent testing has indicated that the stabilized mix has a very low permeability; (1.83×10^{-6} cm/Sec by falling head permeability test) in the same range as clay. This, along with its other physical characteristics, makes it a prime candidate for structural fill applications. Stabilized aggregates with lime and fly ash have been used as bases and sub-bases in highway construction in the U. S. In fact, this material is included in many state and federal agencies' specifications for paving material. Dofasco is currently investigating the possibilities of the use of our stabilized aggregate in such applications.

CHROME RINSE WATER TREATMENT

Dofasco produces both tin plated and chrome plated steel. Each of these processes generates a quantity of chromium contaminated rinse water. After the tin has been plated on to the steel, it passes through a chemical treatment section. Here the surface of the tin plate is passivated in a tank of concentrated sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7$). Since the speed of the strip passing through the tank can be up to 1500 feet per minute, some of the concentrated $\text{Na}_2\text{Cr}_2\text{O}_7$ is carried out with the strip. This is called "dragout". The strip passes through three rinse tanks to remove this residual $\text{Na}_2\text{Cr}_2\text{O}_7$. De-ionized

water is sprayed on the strip as it leaves the final rinse tank. The rinse water cascades through dip tanks and overflows into a rinse collection tank. The rinse process is identical in the chromplating operating except that the strip passes through a bath of chromic acid (H_2CrO_4) rather than sodium dichromate. (See Figure 8)

RINSING: CHEMICAL TREATMENT OR CHROMIUM PLATING

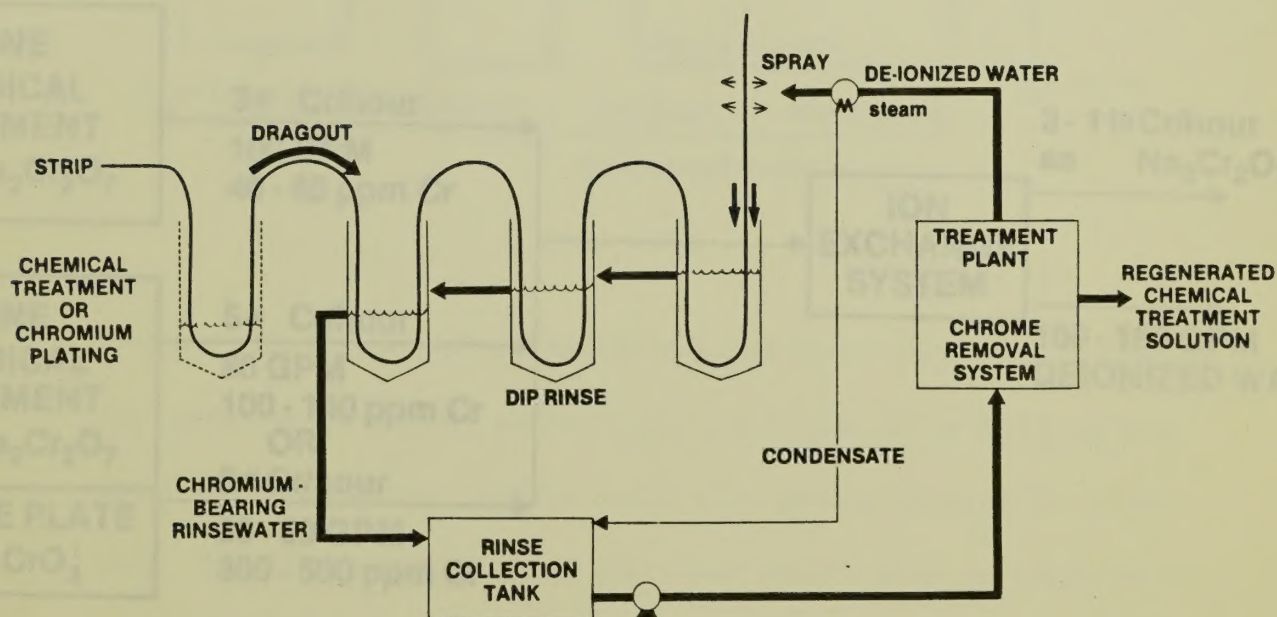


Figure 8

The rinse waters are pumped from the collection tank to the ion exchange unit in the cold mill waste water treatment plant. The chemical treatment and chromium plating rinses from the two electroplating lines contain varying concentrations of chromium.

The average combined concentration is between 40 and 280 ppm Cr.

Normal combined flow rates are between 100 and 180 GPM. This gives a total chrome loading out of the rinse system of 3-11 lbs.

chromium per hours (See Figure 9)

CHROME MASS BALANCE

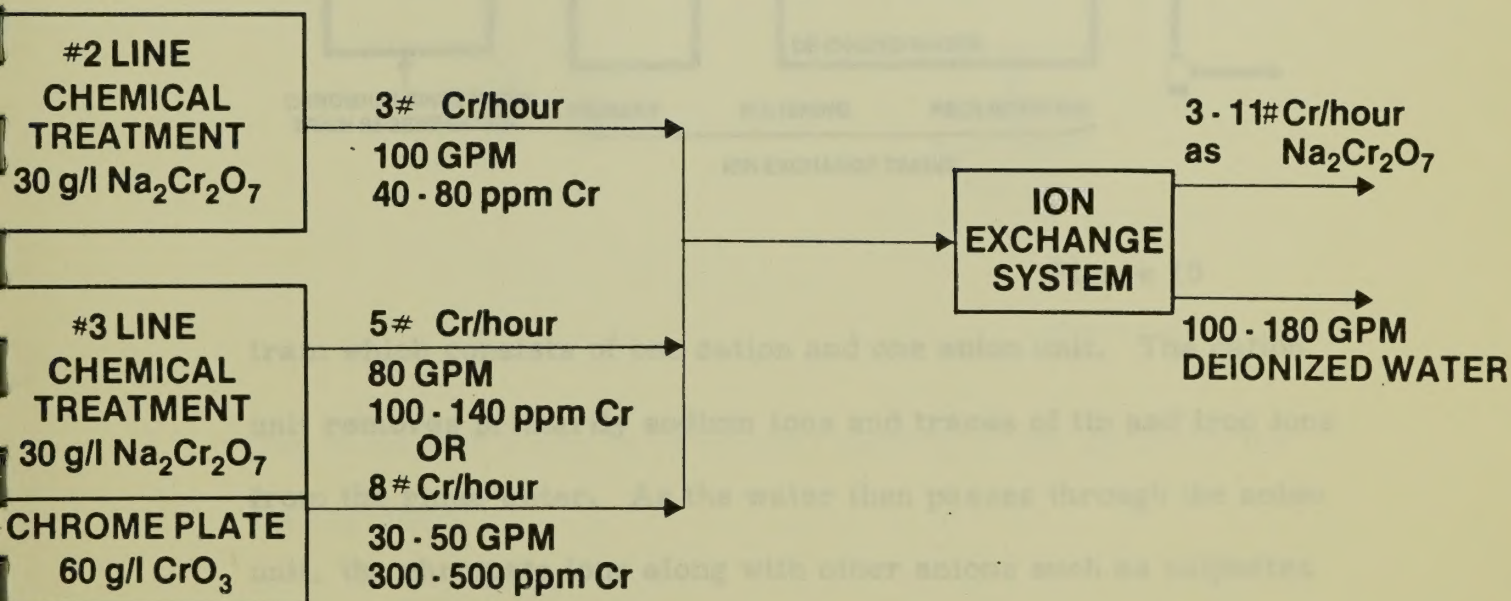


Figure 9

Chemical treatment and chromium plate rinse waters are pumped continuously into the ion exchange section of the cold mill waste water treatment plant. (See Figure 10) A heat exchanger cools the rinses to 80°F to protect the resin in the ion exchange units. Sand filters are next in line to remove particulates to prevent plugging of the resin beds. The rinse then passes through the primary ion exchange

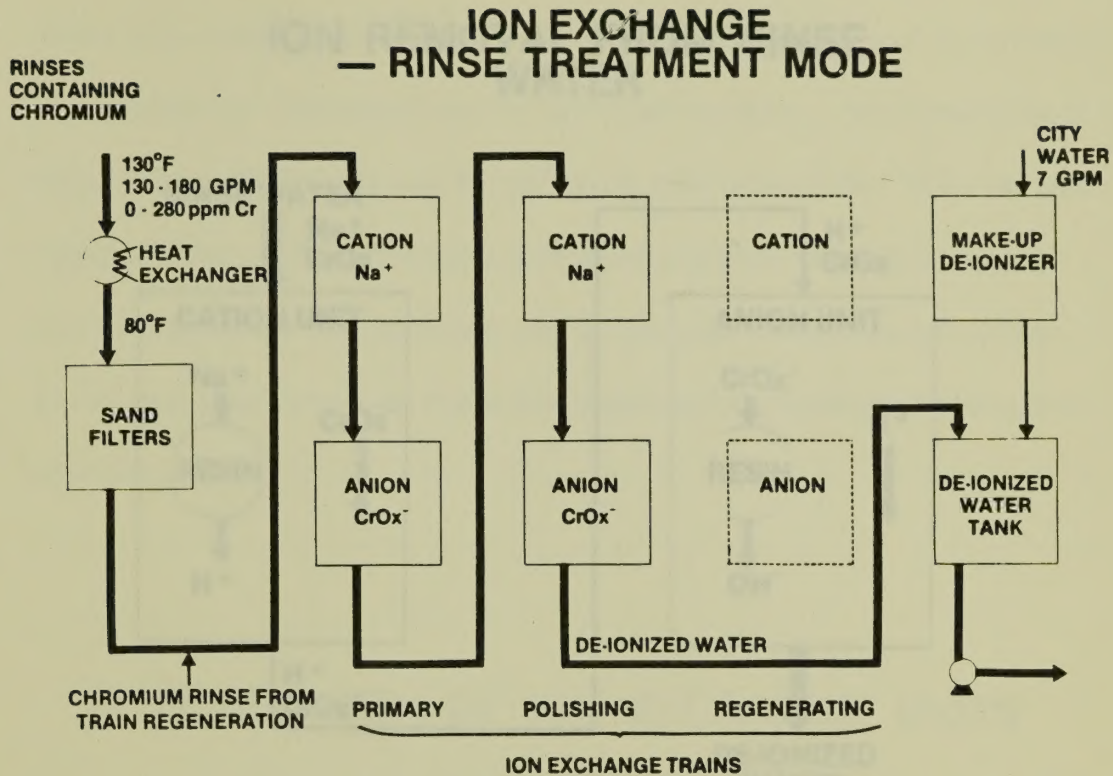


Figure 10

train which consists of one cation and one anion unit. The cation unit removes primarily sodium ions and traces of tin and iron ions from the rinse water. As the water then passes through the anion unit, the chromate ions along with other anions such as sulphates and chlorides are removed. (See Figure 11) The bulk of the ions are removed in the primary train. There is a secondary polishing ion exchange train (cation and anion unit) to remove any traces of ions which are left by the primary train. As the water exits the polishing train, it is de-ionized and has a conductivity of less than 100 micromhos.

ION REMOVAL FROM RINSE WATER

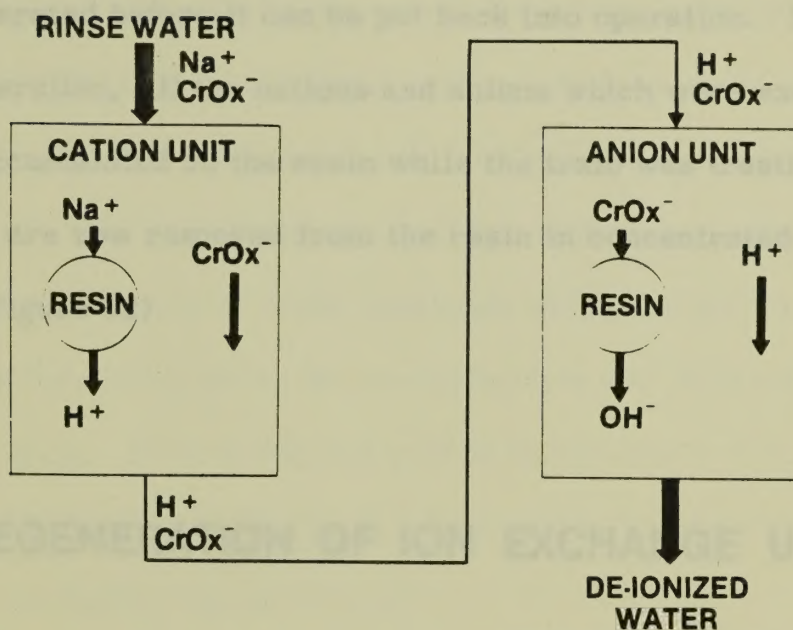


Figure 11

The de-ionized water is re-pumped directly to the sprays at the plating lines.

The third ion exchange train is regenerated and then put on standby awaiting exhaustion of the primary train. A small makeup de-ionizer is located in the cold mill waste water treatment plant to provide approximately seven gallons per minute of makeup water which is lost during the blow down operation on the ion exchange train.

Each anion vessel can hold approximately 500 lbs. of chromium. When this loading is reached, the train (one cation and anion unit) is considered exhausted and is taken off stream. The train must be regenerated before it can be put back into operation. During the regeneration, all the cations and anions which were exchanged and accumulated on the resin while the train was treating rinse water are now removed from the resin in concentrated solutions. (See Figure 12)

REGENERATION OF ION EXCHANGE UNITS

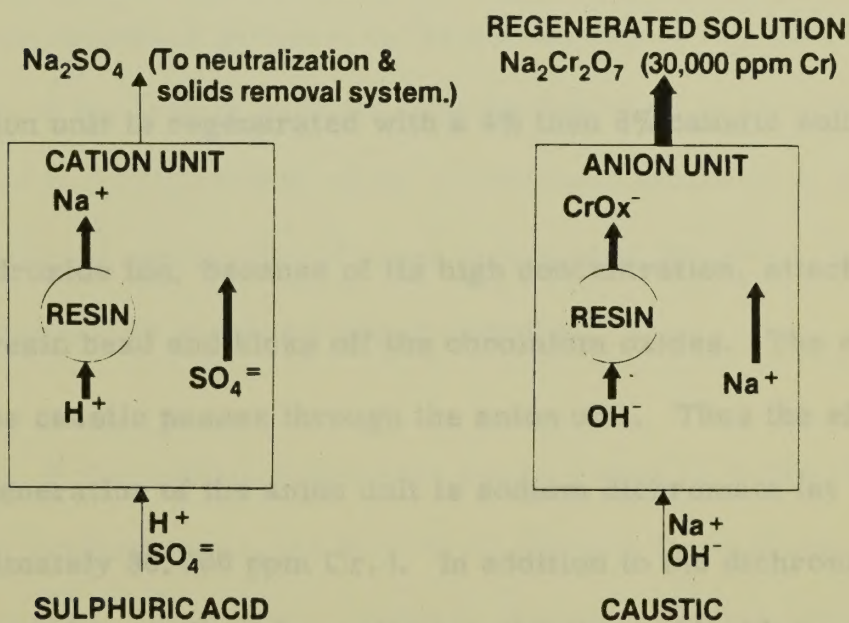


Figure 12

The cation unit is regenerated with an 8% solution of sulphuric acid.

The high concentration of hydrogen ions in the acid reverses the exchange on the resin beads. Hydrogen attaches itself to the resin and kicks off the sodium and other cations which were attached during rinse treatment. The sulphate from the sulphuric acid passes through the unit. The liquid leaving the cation unit contains sodium sulphate and small amounts of metal sulphates which are all waste products. This stream diverted to the neutralization and solids removal system of the plant. After sufficient acid is introduced to fill all the resin sites with hydrogen atoms, the resin bed is rinsed with demineralized water to remove traces of acid.

The anion unit is regenerated with a 4% then 8% caustic solution.

The hydroxide ion, because of its high concentration, attaches itself to the resin bead and kicks off the chromium oxides. The sodium from the caustic passes through the anion unit. Thus the effluent from the regeneration of the anion unit is sodium dichromate (at approximately 30,000 ppm Cr.). In addition to the dichromate regenerated from the anion unit any sulphates, chlorides or other anions which were exchanged during rinse treatment are also recovered in the regenerated solution.

RECYCLE OF SODIUM DICHROMATE

Less than 10% of the 15,000 gal/month regenerated sodium dichromate solution can be recycled to the "E" lines because of the problems of high pH and the high sulphate concentration. The pH of the regenerated sodium dichromate from the ion exchange train averages 6.9. This compares to the range of 4.5 to 6 required in the chemical treatment bath. Sulphates in the regenerated solutions range anywhere from 50 up to 3,000 ppm. An acceptable limit for recycle is 250 ppm. If the sodium dichromate cannot be recycled to the lines, it must be disposed of. This creates three problems. The most important problem is the availability of disposal sites. Because of the lack of suitable disposal facilities in Ontario, Dofasco is forced to transport this waste to treatment facilities in the U. S. The continued availability of these facilities is not sure. Secondly, the disposal cost is continually increasing.

Thirdly, if the sodium dichromate can be recycled to the "E" lines, then the replacement costs of over 40,000 lbs./year chromium can be recovered. As a result, Dofasco has recruited the services of its research department and utilities engineering group to help solve the problems involved in sodium dichromate recycle.

The problem of high pH was investigated first. The first approach was to take a selective pH "cut" of solution during the anion regeneration step. During a normal regeneration, the sodium dichromate is recovered between a pH of 5.8 and 7.6. The solutions pushed from the anion vessel outside of these pH's are low in chromium concentrations. They are normally collected in separate tanks and fed into the influent rinse line. It was found that if the pH start and end point for sodium dichromate recovery was lowered, the buffering capacity of the solution was too great. The pH could only be reduced from 6.9 to about 6.4. Also, when lowering the upper pH limit, a significant amount of sodium dichromate was left out of the regenerated dichromate "cut" and had to be recycled through the system. This significantly reduced subsequent train capacities. Since we were unable to reduce the pH by altering the process variables, a small cation exchanger was installed to remove a portion of the sodium ions from the regenerated sodium dichromate solution. By this method, the pH can successfully be adjusted as required.

The problem of high sulphate concentrations in the regenerated sodium dichromate is being attacked from several angles. The sulphate ions do not bond as tightly to the resin structure as the chromium oxide ions. Therefore, as the anion unit nears exhaustion, the resin sites

taken up by sulphates may be replaced to some extent with chromium oxides. The primary train, therefore, is kept on stream in a state of exhaustion for a certain length of time to try to allow the sulphate ions to be "Pushed Off" of the resin by the chromium oxide ions and into the secondary train. Thus when the primary train is regenerated, it should have a low concentration of sulphate ions. Some anion unit regenerations have produced chemical treatment solutions with low sulphate concentrations. The solution pH has been reduced using the new cation unit and a portion of the regenerated solution is now being recycled to the chemical treatment baths. Using this method, there is a build-up of sulphate ions pushed from train to train. A certain portion of the regenerated solutions will not be acceptable in sulphate levels.

Another approach to reducing the sulphate levels in the regenerated solution is to produce a high sulphate concentration cut during the anion unit regeneration. This would be represented by the left hand sulphate curve on the anion regeneration curve. (See Figure 13)

If this separation of sulphate and chromate peaks can be achieved, then the high sulphate cut could be blown down. The sodium dichromate solution cut would have a low sulphate concentration. Presently, the sulphate curve on any given regeneration ranges anywhere between the two extremes shown in the diagram. The reaction kinetics of

ANION REGENERATION CURVE

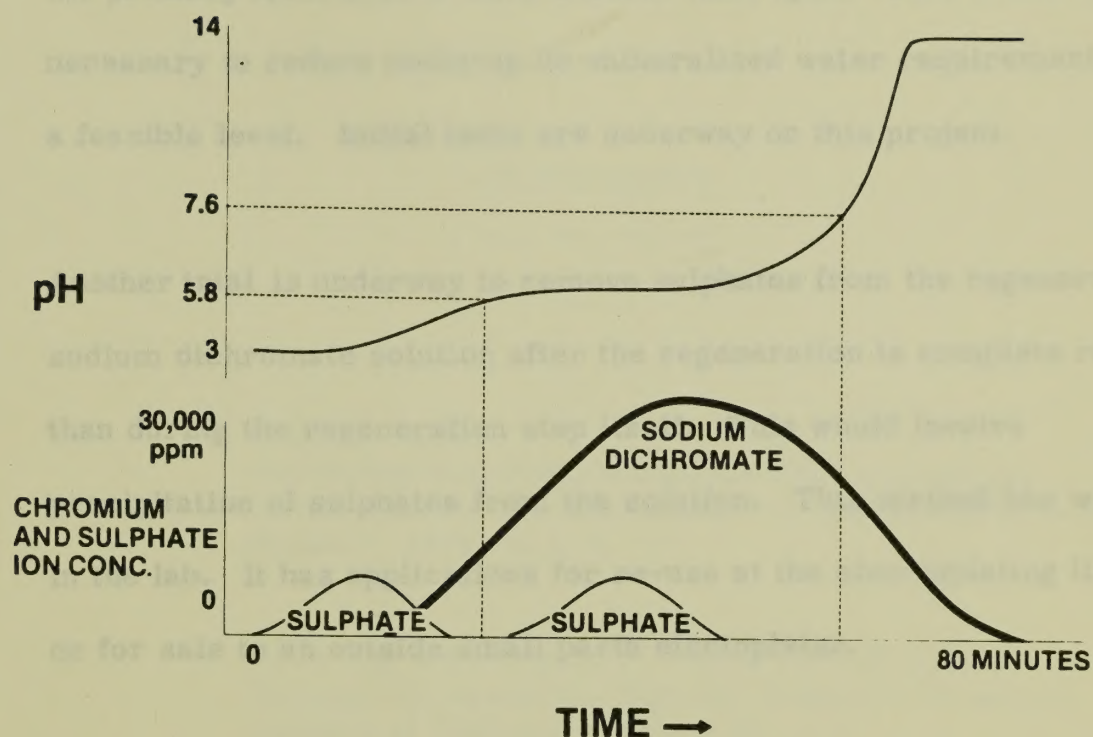


Figure 13

the regeneration will be studied by varying caustic strengths and flow rates in an effort to remove the sulphates from resin during the early minutes of the regeneration.

A third method of removing sulphates involves a blow down of sulphates on stream rather than during a regeneration. The sulphate ions tend to pass out of the primary train as the train accumulates chromium oxides. This water from the primary train could be sewerred rather than passed through the secondary trains up to the point when chromium oxides started to pass from the primary train. This method will only be feasible if a method is found to force the sulphate ions from

the primary train over a much shorter time span. This would be necessary to reduce make-up de-mineralized water requirements to a feasible level. Initial tests are underway on this project.

Another trial is underway to remove sulphates from the regenerated sodium dichromate solution after the regeneration is complete rather than during the regeneration step itself. This would involve precipitation of sulphates from the solution. This method has worked in the lab. It has applications for re-use at the electroplating lines or for sale to an outside small parts electroplater.

Dofasco's current efforts to recycle the regenerated chrome solution have not yet achieved complete success. Chrome contaminated wastes are the only liquid wastes which Dofasco sends out for treatment. Efforts will continue to find a workable solution enabling in-plant treatment and utilization.

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WAYS TO RECYCLE AND REUSE WASTES AT STELCO

Presented by

H. H. EISLER

Environmental Control Manager

Stelco Inc.

WAYS TO RECYCLE AND REUSE WASTES

AT

STELCO

HAMILTON ENVIRONMENTAL CONFERENCE

H. H. EISLER

November 15, 1982

WAYS TO RECYCLE AND REUSE WASTES AT STELCO

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HAMILTON ENVIRONMENT '80 CONFERENCE

Mohawk College

November 15, 1980

I was asked to speak today on the subject of solid waste disposal from a steel plant. However, after examining the subject I have come to believe the title should have been "By-Product Management at Stelco." All wastes are potential by-products, and I hope to demonstrate that most of the material produced in a steel plant, which does not go out as a steel product, becomes a by-product for reuse within the plant or for sale outside.

The main steelmaking solid by-products are as follows:

STEELMAKING BY-PRODUCTS

- 1) Steel Scrap
- 2) Slag - Blast Furnace and Steelmaking
- 3) Used Refractories
- 4) Undersized Coke
- 5) Dross from Tin or Zinc Plating (Galvanizing)
- 6) Garbage - Sanitary and Wood
- 7) Undersized Iron Pellets
- 8) Environmental - from Environmental Control Equipment

1) SCRAP

Scrap steel and iron, of course, is our largest by-product and it is reused directly in the steelmaking process. This "home scrap" is generated by the normal trimming that takes place during rolling and forming operations to ensure high

quality product. In addition, significant quantities of outside scrap are purchased and, in this way, the steel cycle is closed as automobiles, refrigerators, cans and other used steel products are returned for reprocessing.

Hamilton-Wentworth is particularly advanced in the field of scrap recycle. The Solid Waste Reduction Unit (or SWARU) includes a magnetic separation step. This separates out steel products, notably cans, often erroneously called "tin cans."

This recovered steel scrap is sent to another Hamilton Company, Metal Recovery Industries (a Division of American Can Canada Inc.) who have a process for the removal of tin plating from steel cans. This Company may de-tin the scrap and recycle it to a steel company or sell it to a company which is able to use the scrap without de-tinning.

2) SLAGS

Slags are solid residues from the purification of molten iron and steel. They are skimmed off the top of the molten metal rather like the scum formed in home cooking. Slags are similar in chemical composition to natural rocks and minerals in the earth's crust so they can be substituted for these increasingly scarce commodities.

a) Blast Furnace Slag

Blast Furnace slag may be produced in several forms depending on the method of cooling.

- a) (i) Simple air cooling produces a slag which has qualities similar to stone and it can be used in similar ways for road building, railroad ballast, concrete aggregate and as a foundation material.

- a) ii) Secondly, the molten slag may be expanded during the cooling process by contacting the molten slag with steam and/or water under controlled conditions to produce light-weight aggregates. These are used in such by-products as light-weight concrete blocks in the construction industry. However, another important use is developing in the cement industry. This light-weight slag may be ground and used as a cement replacement. This has been done in various European countries for up to 50 years. The North American cement industry is starting to produce larger quantities of slag cement now that the era of cheap energy in North America has passed. The slag portion of cement can be prepared by simple grinding, whereas the normal constituents have to be processed through a kiln where four to eight million BTUs of energy per net ton are required.

- a) (iii) A third form of blast furnace slag is produced by direct water quenching in a tank. It yields a product similar to sand and the end use is as a cement replacement in the same way as light-weight pelletized slag.

In Canada, air cooled and light-weight pelletized slags are produced. Some of the slag is retained in the plant for use as foundation or road-building material, while the remainder is sold for the uses mentioned above. It is worth noting that blast furnace slag, in both the light-weight and air cooled forms, is lighter than crushed stone and, therefore, it has a competitive advantage for aggregate use, since the cost of transportation forms such a significant portion of the final product cost.

b) Steelmaking Slag

Steelmaking slag is somewhat similar in appearance to air cooled blast furnace slag but is darker in colour and considerably heavier and contains nuggets of metallic iron. In the early days, the slag was picked over and screened to remove the major pieces of iron and steel and the remainder, so-called non-metallic slag, was used for landfill.

However, this so-called non-metallic slag still has considerable quantities of iron and other materials present which are of value in the Blast Furnace and Sinter Plant and, therefore, a practice was adopted whereby the slag is further screened, with the result that about 40% of the previously so-called non-metallic slag can be recycled to the Blast Furnace and the Sinter Plant for its metal value and flux content. (The Sinter Plant process is described later.)

The remaining non-metallic material is useful as a fill material, but it suffers in a competitive market because it is heavier than stone.

For this reason, Stelco instigated research at McMaster University to examine other uses for steelmaking slag. The results of the study in the period 1974 to 1976 concluded that steel slag used for asphalt road pavement, when compared to the best competitive mixes (HL1), had equivalent wear resistance, superior skid resistance, similar compact ability, and excellent stripping resistance. These factors are especially useful in the final wearing course of asphalt.

Based on the results of the McMaster research, the Ministry of Transport and Communications placed a patch of steel slag asphalt mix on Highway 401 at Keele Street in Toronto. Extensive testing of this patch resulted in steel slag being designated as an acceptable material for H11 mixes and steel slag has been sold for this use since that time. We anticipate that, in the future, all our excess steelmaking slag can be marketed in this manner.

3) USED REFRACTORIES

Large quantities of refractories, such as high temperature bricks, are used in steelmaking operations because of the intense heat needed in iron and steel production processes. The refractory bricks eventually deteriorate and furnaces have to be relined with some or all of the existing bricks being discarded. Such bricks are inert and are generally quite suitable for landfilling.

4) UNDERSIZED COKE

Undersized coke is not used in the Blast Furnace since small size coke would be quickly blown out and wasted and, as well, would cause operating problems. Therefore, it is screened out and excess coke is sold to the ferroalloy industry as a fuel for cupola furnaces.

5) DROSS FROM TIN OR ZINC PLATING (GALVANIZING)

A dross high in metal content rises to the surface in certain plating operations and, because of the high monetary value of these metals, the dross is sold for the recovery of tin and zinc.

6) GARBAGE - SANITARY AND WOOD

Sanitary and wood garbage is treated in the same way as the average homeowner and is sent to the local waste reduction unit or landfill site. As a matter of interest, in Hamilton-Wentworth there is a secondary industry in which people are employed to inspect wood garbage and recover useful lumber for sale, thus providing employment for additional people, while recovering a useful product.

7) UNDERSIZED IRON PELLETS

8) ENVIRONMENTAL - FROM ENVIRONMENTAL CONTROL EQUIPMENT

Items 7 and 8 are treated in a similar way and I will consider them together. Table II illustrates the principal materials collected through the environmental control program. Most of the materials on this list contain iron which, of course, is the raw material in the steelmaking process. However, most of these materials are too fine in size to be charged back directly into the ironmaking or steelmaking processes. They need to be agglomerated before they can be recycled.

The most common process for this agglomeration is called "sintering."

In the Sinter Plant the by-product iron oxides, along with a carbon fuel, are placed on a travelling grate. The mixture is ignited and air is pulled down through the mixture to burn the fuel by down-draft combustion. The materials are sintered together into porous, coherent lumps which can be recycled to the Blast Furnace as a valuable source of iron.

Blast Furnace flue dust is an ideal material for the Sinter Plant since it contains both iron and carbon particles to act as a fuel. It, along with Blast Furnace filter cake, the mill scale from the rolling operations, and dust from the Sinter Plant's own environmental equipment are fed to the sinter strand. The pellet fines mentioned earlier originate as screenings from the ore fed to the Blast Furnace. They are included in this Sinter Plant burden to enable them to be used in the Blast Furnace. In this fashion, the Sinter Plant enables Hilton Works to recycle, each year, almost three quarters of a million tons of materials which are collected mainly through our environmental control program.

Coke breeze is sold as a by-product, as described earlier in relation to undersized coke.

Regenerated Oxide from pickling recycle and regeneration system arises from a process for cleaning the surface of steel called "pickling." Pickling involves removal of iron-bearing scale, dirt, etc. from the surface of the steel. In the regeneration process, a fine iron powder is separated from the acid which is recycled to the process. The iron powder has proven to be valuable to the ferrite industry. An example of this use is in the manufacture of recording tape.

Steelmaking baghouse dusts arise from the collection and cleaning system on conveyor systems feeding flux and additives to the steelmaking furnaces. The dust is predominantly fluxing agents, lime and dolomite. Therefore, it is useful as a neutralizing agent in certain waste water treatment systems.

The two remaining solid by-products are steelmaking precipitator dusts and miscellaneous baghouse dusts. These are not sent to the Sinter Plant, due to lack of Sinter Plant capacity and because they may contain elements such as zinc which could cause damage to the crucial brick lining of the Blast Furnace if recycled. These elements arise from the scrap fed back to the steelmaking furnaces. Zinc, of course, arises from scrap galvanized metal.

Considerable research has been conducted in an effort to find an economically viable method to recycle this valuable material.

As a result, several processes have been developed which involve hot or low temperature briquetting of this material. If a stable pellet or briquette can be achieved, there is a chance for some recycle to the steelmaking furnace, but this is limited by its cooling effect in the bath. As a result, it has had limited application in North America because of high capital cost and the fact that it will solve only a portion of the problem. Recycle to the Blast Furnace is not possible since these processes do not remove the elements which are harmful to the brick linings. The most favourable process offering hope of recycle is a reduction kiln. This process promises to both separate the undesirable elements and produce a product which is recycleable to the Blast Furnace. Unfortunately, the high capital cost associated with these plants has meant that no installations of this type have been built at major steel plants in North America. The material is being stored or landfilled for future reclamation when the economics, and perhaps the technology, make that course of action possible.

CONCLUSION

The steel industry is an interesting example of the possible total recycle of its *basic* product through the reuse of scrap metal. In addition, *by-product* solid materials are capable of recycle to a significant degree. At Stelco's Hilton Works 88% of steelmaking solid wastes on a tonnage basis is recycled.

An industry-wide effort is continuing to find viable methods of recycle for the remainder.

1) Steel Scrap

. . .

2) Slag - Blast Furnace and Steelmaking

3) Used Refractories

4) Undersized Coke

5) Dross from Tin or Zinc Plating (Galvanizing)

6) Garbage - Sanitary and Wood

7) Undersized Iron Pellets

8) Environmental - Does Environmental Control Equipment

TABLE I

- 1) Steel Scrap
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- 7) Undersized Iron Pellets
- 8) Environmental - from Environmental Control Equipment

TABLE II

- 1) BLAST FURNACE FLUE DUST -- coarse materials from Blast Furnace (B.F.) gas cleaning
- 2) BLAST FURNACE FILTER CAKE -- finer materials from B.F. gas cleaning water recycle system
- 3) MILL SCALE -- from scale pits and filters following rolling of hot steel
- 4) SINTER PLANT BAGHOUSE DUST -- from strand cooler and conveyor dust collection systems
- 5) COKE BREEZE -- fine coke from quench settling pond
- 6) REGENERATED OXIDE -- from pickling recycle and regeneration system
- 7) STEELMAKING BAGHOUSE DUST -- from conveyor dust collection systems
- 8) STEELMAKING PRECIPITATOR DUST
- 9) MISCELLANEOUS BAGHOUSE DUST -- e.g. following grinding of billets to remove imperfections

THE HISTORY AND FUTURE
OF
SEWAGE COLLECTION AND TREATMENT
IN THE
HAMILTON-WENTWORTH REGION

by

K. Brenner - Environmental Planning Engineer

BACKGROUND:

The Hamilton-Wentworth Region was established in 1974 and became the government agency responsible for the collection and treatment of sanitary sewage in the Region.

The aim of this paper is to give a short insight into the history, scope, and future of the sewage collection and treatment system in the Region.

HISTORY:

The land around Burlington Bay, which was once known as Lake Geneva, had been occupied at one time by Indians, but was essentially unoccupied, due to the Huron wars, near the end of the 18th Century. At that time, the present settlement commenced.

The size and complexity of the sewage disposal system grew as the size of the Community increased. Initially, people had an outhouse behind their house and the wash water was thrown out the front or back door. This led to a grandiose mess on the streets as the number of houses increased. To solve this the Municipalities started to lay pipes along the streets to drain the excess liquid to the nearest water course. In due course this became unacceptable and the Municipalities had to get into the business of sewage treatment.

Cont'd.....

The History and Future
of Sewage Collection and Treatment
in the
Hamilton-Wentworth Region

Cont'd.....

HISTORY: Cont'd....

There is no record as to when the first piece of the sewage collection system was constructed. However, by 1855 the construction of the system was well under way. About that time, major sewers were constructed on Catherine Street and James Street. Incidentally, these sewers are still in service. The collection system now includes some 1,000 km of sanitary and combined sewers varying in size from 15 cm to 3 m in diameter.

The question of sewage treatment arose in the second half of the 19th Century and, before the turn of the Century, the City Engineer of Hamilton reported severe, obnoxious, and unacceptable pollution in some of the inlets along the south shore of the Bay. By the middle of the 20th Century the Town of Dundas had one sewage treatment plant and the City of Hamilton three. About that period the City abandoned its three plants and built a new one on Depew Street. All of these plants by today's standards, were simple processes and could not even be compared to what now are called primary treatment plants.

In the 1950's a new cycle of sewage treatment plant construction commenced. The result of this programme is the present system, consisting of three new plants and one temporary lagoon. The older plants have all been abandoned. The present plants are located at Main Street, Waterdown; King Street, Dundas; and Woodward Avenue, Hamilton.

Cont'd.....

The History and Future
of Sewage Collection and Treatment
in the
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Cont'd.....

HISTORY: Cont'd.....

The Main Street plant has a nominal capacity of 2700 m³/day and consists of primary treatment, activated sludge secondary treatment, phosphorus removal, chlorination and polishing filter. The effluent is discharged to Grindstone Creek.

The King Street plant has a nominal capacity of 18,000 m³/day. The first four stages of treatment are similar to the Main Street Plant. The last stage, instead of a polishing filter, consists of an aerated lagoon to further improve the quality of the plant effluent. The lagoon is part of the former Desjardins Canal.

The Woodward Avenue plant, the largest of the three, has a nominal capacity of 300,000 m³/day and consists of primary treatment, activated sludge secondary treatment, and chlorination.

The sludge solids produced at the two smaller plants is usually disposed on land. At the Woodward Avenue plant solids are digested, filtered, and incinerated at the site.

These plants have been built over the last 20 years and have a replacement value of approximately \$63,000,000. Present operating and maintenance cost is some \$4,000,000. annually.

Cont'd.....

The History and Future
of Sewage Collection and Treatment
in the
Hamilton-Wentworth Region

Cont'd ...

HISTORY: Cont'd ...

To get the sewage to the new plants it has been necessary to construct an extensive system of collectors and pumping stations. The system now contains some 23 pumping stations. This system is capable of intercepting and conveying all of the sewage to the treatment plants in dry weather. However, during heavy rains, this is not possible due to combined sewers in parts of the system. The flow in a combined sewer may, during heavy rains, be 20 times as great as the flow during dry weather. The discharge of some diluted sewage is unavoidable during heavy rain.

The combined sewer system serves the majority of the people who have sewage service and cannot be replaced in the short run with a separate system at an economical cost. The system has over 20 outlets and over 100 internal overflows. The frequency of overflow varies, but one major one discharges about 50 times a year.

All new sewers constructed in the last 15 years are separate sewers, which has the result of reducing continually the relative impact of the combined sewers.

FUTURE:

As you see, the fight to reduce pollution has been going on for about 100 years, and continues to be of primary concern to the Region.

Cont'd ...

The History and Future
of Sewage Collection and Treatment
in the
Hamilton-Wentworth Region

Cont'd ...

FUTURE: Cont'd ...

It is a costly process and much of the money required must come directly from the local tax payers.

The Region is prepared to do its part in the future. In the next five years we expect that the three treatment plants will be expanded and the effluent further improved; the temporary lagoon will be abandoned; sewer services will be made available to some areas with malfunctioning septic tank systems; and one major combined sewer overflow will be cleaned up.

The last project is a \$3 - 5 million facility on Greenhill Avenue. It will reduce the incidence of overflow by about 80% and will provide some treatment for the remaining 20%. This will greatly reduce the pollution in Red Hill Creek.

A study is also in progress to determine technical and economical solutions to pollution in Chedoke Creek. Remedial action is contemplated between 1985 and 1990. This, together with modifications to the outfall from the King Street Sewage Treatment Plant, will improve the water quality in Cootes Paradise substantially.

CONCLUSIONS:

In conclusion, the Region and its predecessors have been working for about 100 years to protect water quality in the area. In the last 20 years, considerable success has been achieved and we are convinced that further improvements will be achieved.

COMPUTER MODELLING OF HAMILTON'S
URBAN DRAINAGE SYSTEM

by

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ABSTRACT

A joint study on the 120 square kilometer urban drainage system in the city of Hamilton by McMaster University and the Hamilton-Wentworth Regional Engineering Department was recently implemented. The Ontario Ministry of the Environment is also participating in part of the study. The quantity and quality of stormwater runoff, combined sewer overflows and dry weather flow into Cootes Paradise and Hamilton Harbour have been modelled. Various strategies for minimizing pollutant loadings into these receiving waters are being formulated and compared.

The drainage system comprises 3 major drainage basins, with 15 combined sewer outfalls (greater than 1.22 m diameter) and 290 known active diversion structures. The drainage basins are aligned along prevailing storm tracks. Pollutant loads to the receiving waters appear to be sensitive to the causative storm motion and dynamics and consequently an accurate description of storm rainfall is required. Ten rainfall-intensity monitoring stations recording at a resolution of one minute in conjunction with 7 streamflow monitoring and water quality sampling stations provide a large base of synchronized data: rainfall intensity, rainfall direction, rainfall quality, flowrates, suspended solids, BOD₅, total phosphorous and total nitrogen. Water quality analysis is being carried out by the MOE.

The paper includes a brief description of the drainage system, the field equipment and the Stormwater Management Model (SWMM) for the study area. The paper also describes the data acquisition system and the programs used to develop a management strategy for minimizing pollutant loadings to the receiving waters from the combined sewer and drainage system.

INTRODUCTION

Purpose of the Study

Hamilton contains diverse land use characteristics ranging from intense industrial activity to large expanses of open recreational parkland. Hamilton Harbour receives stormwater runoff from virtually the entire City of Hamilton, much of the runoff being polluted. The Ontario Ministry of the Environment is currently developing a numerical model of the harbour to investigate the effects of this urban stormwater discharge on the quality of the water in the harbour.

The purpose of the present study is to formulate a model of the Hamilton urban drainage system, in order to estimate annual loadings to the harbour receiving waters of the following pollutants:

- Suspended Solids
- BOD₅
- Nitrogen
- Phosphate
- Coliforms

It is intended that, after suitable calibration, the urban drainage system model will be interfaced with the model of the receiving waters and operated on a continuous basis to evaluate the long-term effect of urban stormwater discharge on the harbour environment, and, conceivably, management alternatives.

Review of Previous Work

There have been several previous investigations of the performance of the combined sewer system in the City of Hamilton. These studies generally considered only local problems, rather than addressing the problem of combined sewer overflows for the entire city.

The Stormwater Management Model (SWMM) Verification Hamilton Test Catchment Study (1) undertook to calibrate and verify SWMM using field data. This was achieved for the SWMM RUNOFF quantity simulations. However, in the quality sections of the simulation, inadequate levels of agreement between calculated and observed values of BOD₅ and suspended solids were obtained. This lack of correlation was thought to be due to changing land use patterns in the test catchment, observed during the study period.

The Proposed Greenhill Combined Sewerage Storage Facility Study (2) was an investigation of the feasibility of providing storage for combined sewer overflows in the Redhill Creek Basin. This study successfully used the Storage Treatment Overflow Runoff Model (STORM) (3) to model runoff water quality. The algorithms used in STORM to simulate water quality are essentially identical to those used in SWMM. In this case, STORM was calibrated against 14 years of continuous rainfall data from the Royal Botanical Gardens and combined sewage samples obtained from the Hamilton Sewage Treatment Plant.

The McNab Street Relief Sewer Study (4) and the King Street Sewer Study (5) also used STORM. In these cases, the model was calibrated against available combined sewer overflow data.

Another significant study in this area was the Redhill Creek Watershed Management Study (6). This study indicated that direct discharge of drainage and leachate from the Upper Ottawa Street Landfill site contaminated the upper reaches of the Redhill Creek. It is not within the scope of this present study to model this pollution source.

A water quality study of Cootes Paradise (7) suggests that Chedoke Creek contributes a significant input of nutrients, chlorides, suspended solids and bacteria to the receiving waters, but does not identify the sources of this pollution explicitly.

Scope of this Paper

This paper summarizes the first phase of the study; i.e., the development of a stormwater runoff model of the City of Hamilton's urban drainage system.

All available hydrologic and hydraulic data for the system were collected, reviewed and synthesized. This data base is used to develop a representation of the drainage system compatible with the Stormwater Management Model.

The structure of the drainage system has been verified through simulation of a rainfall event.

THE STORMWATER MANAGEMENT MODEL

The Stormwater Management Model (SWMM) is a U.S. computer program capable of simulating urban stormwater runoff and combined sewage overflows. Its development was a joint effort of Metcalf and Eddy Inc., Water Resources Engineers Inc., and the University of Florida. The program requires rainfall, pollutant and basin characteristics as input, and calculates stormwater quantity and quality. These processes are performed by four main model segments.

Rainfall hyetographs are distributed evenly over each sub-catchment within each time interval (typically one to five minutes). The drainage area is characterized by its size, degree of imperviousness, slope and several factors describing pollutant accumulation over the area. The available depression storage and infiltration potential are satisfied before runoff occurs. Overland flow is then considered, using the kinematic wave formula based on Manning's equation and continuity at each time interval. The overland flow may be routed through small pipes and gutters in its travel to an inlet manhole for the TRANSPORT system. The rate of overland flow determines the amount of the available surface pollutants washed off. Thus, at the inlet, a temporal description of the flow and the pollutant mass washoff is available.

The transport segment represents the physical works that convey surface runoff hydrographs and pollutographs from the contributing subcatchments to the point of discharge of the system. This may be the storage treatment facility, or the receiving waters. The inlet flows are modified by combination with flows from other drainage areas and with dry weather flow in the system. The flow and pollutant discharge rates are attenuated during their passage through the conveyance network to an extent dependent upon the capacity of the system and the function of in-system storage. The resultant flow velocity in each element controls the deposition or scour of solids. Flows may be diverted at various points in the system, either to overflow locations or to treatment facilities.

The hydrographs and pollutographs generated, such as by dry weather flow, may be routed to storage units. These are specified by simple regular geometries with various alternative inlet and outlet controls. Pollutants are considered to settle out in the storage facility, while additional improvements in quality may be modelled in a variety of optional treatment units. The resulting attenuated hydrographs and pollutographs can form the input to the receiving water segment.

The geometry of the receiving waters is described using a network of nodes and channels. A simple system may be considered as a series of channels. The hydrographs and pollutographs are used as input to different nodes in the receiving water and the subsequent responses investigated. The equations of continuity, motion and conservation of mass are solved in order to establish the variations in water level and pollutant concentration at locations (nodes) of interest over several days. The effect of different treatment policies may be evaluated through a series of simulations.

FASTSWM

In this study the FASTSWM package, developed at McMaster University, has been used. FASTSWM is a program package that makes it possible to run parts of SWMM from a terminal in a pseudo-conversational mode.

The package is easily maintained by simply updating the basic SWMM modules in accordance with the latest modifications and corrections issued by the original authors. These basic modules have not been modified by the present author.

The basic processes included in the package are:

- (a) solicit job control data to identify or set up the necessary user files (user name, case number, new file).
- (b) solicit and accept user-directed basic SWMM input in conversational free-format mode, usually from a remote terminal, if a new file.
- (c) check the validity of the free format input data and return values of certain dependent parameters to the user terminal.

- (d) copy and save the user's free-format input in a special file defined by the user's initials and a case number, if a new file.
- (e) convert from metric units to the Imperial units required by SWMM, if necessary.
- (f) copy and save the properly formatted data in Imperial units in a special SWMM input file also defined by the user's initials and case number.
- (g) submit the blocks of SWMM in the order required.
- (h) save the SWMM output file, identified by the user's initials and case number.
- (i) return selected output from the SWMM output file to the user terminal, and reconvert to metric data if required.
- (j) plot both the calculated and observed (if any) hydrographs and calculate the linear cross-correlation coefficient between the two.
- (k) list the SWMM output file as directed by the user at the central site.
- (l) re-submit the SWMM blocks as directed and return selected output, and repeat as required.

Steps (a)-(g) are handled by the pre-processor, steps (h)-(k) by the post-processor. The procedure has been carefully designed to minimize user errors and reduce total design turnaround times. The FASTSWM package evidently reduces considerably the complexity of the SWMM job submission; users are able to focus on the hydrologic, hydraulic and water quality processes modelled. No knowledge of FORTRAN formats, or systems control language is required of users.

FASTSWM comprises three parts: PRESWMM, SWMM and POSTSWM. A copy of the user's free format input file is saved as NNNDATX where NNN are the user's initials and X is the study case number. X may be any character. This file may be freely accessed and edited using the usual system editing facilities. Similarly the final output file NNNOUTX may also be accessed, edited and listed at the user's terminal.

SWMM is the main part of the program and is automatically submitted to a central processor unit as a remote batch job by the FASTSWM program.

PRESWMM works in an interactive mode and prepares the input for SWMM. PRESWMM makes it possible for the user to enter his input in free format. It also converts units from metric to IMPERIAL (FPS).

POSTSWM also works interactively. It returns selected results to the user and reconverts the data to metric units. It plots the computed hydrograph and the observed hydrograph (if any), and computes the linear cross-correlation coefficient.

Basic Hydrologic and Hydraulic Concepts

During precipitation on a pervious area, water is continuously abstracted by infiltration. Other abstractions considered in rural hydrology, such as interception and evaporation are usually negligible for urban storm events. If the rainfall intensity exceeds the possible rate of infiltration, natural depressions collect some of the excess precipitation creating depression storage. Since the depressions have different depths and filling rates, some overland flow commences as soon as the infiltration capacity is satisfied.

Each subcatchment is conceptualized as a flow plane over which overland flow occurs. Representative values of imperviousness, average ground slope, infiltration, retention storage, and land use are assigned to each subcatchment. The rainfall depth over each subcatchment is the basic input to overland flow. The model sequentially accounts for infiltration and retention depth to determine a net excess rainfall depth on the overland flow plane. The excess rain depth is used to compute an overland flow rate for each time step. Subcatchments can be used to represent large portions of the entire watershed, or individual drainage area, depending upon the desired degree of detail. The small local sewer pipes and gutters are usually ignored in large subcatchments.

SWMM combines the runoff flows from several subcatchments and routes these flows through the main sewer network. Several urban runoff models of varying levels of sophistication have been developed for the simulation of this process. Such Transport models range from those using simple time-offset methods to those employing complex numerical schemes for the solution of the dynamic wave equations. While the latter approach is applied by some discrete models, long term simulation models generally use simpler techniques and others do not consider sewer routing at all (e.g. STORM). A comprehensive Transport model should be able to account for:

- (a) the unsteady and nonuniform nature of flow through sewers;
- (b) the storage capacity of the sewer system;
- (c) the dynamic effects of the backwater condition and the energy losses along the sewers and at manholes;
- (d) control elements including manholes, weirs, orifices, pump stations, storage units and gates;
- (e) the distribution of flow through branches and looped systems;
- (f) flow reversal and adverse sewer grades; and,
- (g) the variety of conduit shapes commonly encountered in engineering practice.

All are accounted for in SWMM.

SCHEMATIZATION OF THE HAMILTON DRAINAGE SYSTEM

In computational modelling, a large portion of the study effort is devoted to the preparation of input data for the computer model, and interpretation of the resulting output. Any stormwater modelling study must have a complete and up-to-date data base upon which to draw. The model results are as reliable as the data upon which they are based, a point often overlooked by modellers.

With this in mind, a major objective of this study was to collect and document a comprehensive, reliable data base for stormwater studies in the City of Hamilton. It was felt this would encourage confidence in the simulation results, and help identify data deficiencies and areas which may require further investigation.

Review of Available Data

A significant portion of the requisite data already exists in the City of Hamilton neighbourhood maps. These drawings detail the storm, sanitary and combined sewers, and the location of diversion structures, combined sewer overflow structures and outfalls. These maps are at a scale of 1" = 100'. At this enlarged scale it is not possible to comprehend the drainage pattern in each area. Hence, the information was transposed to Hamilton district maps, at a scale of 1" = 400'. This also helped to highlight many inaccuracies and discrepancies in the neighbourhood maps. Typical problems included sewers which apparently do not connect, junction points where the flow pattern is difficult to trace, and numerous other structures for which the actual performance was difficult to determine. In an effort to resolve these problems, discussions were held with officials from the Hamilton Wentworth Regional Engineering Department. In addition, reference was made to the construction drawings for the structures and sewers. For many of the areas where further information was needed, particularly in the older sections of the city, detailed construction drawings are no longer available or never existed. The study proceeded using available information, but assumptions and estimates were occasionally necessary.

System Discretization

In order to model the system accurately and to facilitate processing, it is necessary to reduce the total study area into a number of smaller sub-areas. A natural basis for this division was to identify initially the main drainage basins in the city, specifically the Chedoke Creek basin, the Redhill Creek basin, and the central core of the city which drains directly, through a number of outfalls, into Hamilton Harbour. The location of these drainage areas is shown in the figure. For the purposes of this investigation, each basin is treated as an independent study area.

The next step in the discretization process was to divide each drainage basin into smaller contributory subcatchments. Here, we assume that under high-flow conditions every diversion structure routes all flow to the nearest outfall. The subcatchments contributing runoff to selected structures and outfalls in the system were then identified. The figure shows the subcatchment discretization. There is a high



density of overflow structures in the central core of the city and a lack of reliable data.

Once the subcatchments had been delineated, each was parameterised in terms of the required program input. These parameters include the physical characteristics for each subcatchment, initial pollutant loadings, surface quality characteristics, and the natural and constructed drainage pattern in the basin.

WATERSHED DATA

During subcatchment delineation and the abstraction of conduit data (i.e. length, slope, diameter) from the neighbourhood maps, a number of discrepancies and inaccuracies were found. These included partial or conflicting conduit specifications, discontinuous conduit sections and information that could not be interpreted. As part of our comprehensive study we attempted to obtain details of the performance of the overflow structures in the Chedoke basin.

Subcatchment Definition

After the transposition of the data to the district maps, the subcatchment boundaries were defined, as illustrated in the figure. The subcatchment discretization is much finer in the Chedoke Basin, for which a more detailed runoff quality study is currently underway. Using the same catchment boundaries in this basin should aid in the calibration of the entire model, and allow comparison of the two simulations.

Hydrologic Data

After defining the subcatchments it was necessary to characterize each by a number of parameters including imperviousness, ground slope, surface roughness, amount of detention storage, infiltration rate and the subcatchment width. In some cases the parameters are estimated and would require a more accurate definition in subsequent studies.

Imperviousness

Each subcatchment must be quantified in terms of the percentage of land area which drains directly to the sewer system and the percent impervious. This includes roadways, parking lots, driveways, and roofs with connected downspouts.

A reasonable estimate of the percent impervious can be obtained based on land use patterns. For this study, air photos were used to provide a land use inventory for the area under consideration.

Seven different land use categories were defined, and each land use type was assigned a typical percentage impervious area. The percent impervious values were estimated based on field observations and experience.

The land use in each subcatchment was determined. This was done by overlaying subcatchment boundaries on a land use map and estimating the land use composition. Knowing the subcatchment land use distribution, and the corresponding percent impervious for each land use, the weighted percent impervious for each subcatchment was calculated.

Flow Routing

In a detailed stormwater runoff quantity study, hydrographs for each subcatchment would be generated and these hydrographs would then be routed through the drainage network. SWMM is capable of simulating pipe surcharge, backwater effects, hydraulic structures and other flow routing phenomena. However, the level of sophistication of the routing algorithms contained in these blocks is often not commensurate with the degree of detail of the hydrologic simulation. The aim of our stormwater study is to provide an indication of total loadings to a receiving water over long time periods and the use of detailed routing models is not justified when all sources of potential error are considered.

Hydraulic Data

For the coarse level of discretization at which the Hamilton system is being modelled, only major open channels and pipes 36 inches and greater in diameter were considered in constructing the transport system. Each conduit and its upstream and downstream nodes were given identification numbers. The numbering scheme is presented in the figure.

Each conduit was described in terms of the upstream inlet or node, its geometry, length slope, roughness (Manning's "n") and downstream inlet or node.

Surface Quality Data - General

The surface quality data required for SWMM relate to the amount and type of pollutants which accumulate on the ground prior to a storm event and the rate at which they are washed off. The amount and type of pollutant will vary depending on factors such as the type of land use, the length of gutter where pollutants are allowed to accumulate, the frequency and efficiency of street cleaning operations, and the number of catchbasins removing pollutants from the flow path.

The following eight quality parameters were considered in this study:

1. settleable solids
2. suspended solids
3. coliforms
4. BOD₅
5. COD
6. Nitrogen (N)
7. Phosphate (PO₄)
8. grease and oil

Total loadings and pollutographs of each of these quality parameters were calculated for all outlets in the three drainage basins as well as pollutographs for the individual subcatchments within the drainage basins.

Land Use Classification

The following designations were used to classify the land use in each subcatchment:

1. single family residential
2. multiple family residential (includes town houses and apartments)
3. commercial
4. industrial
5. undeveloped or park lands (includes institution grounds and green areas)

The predominant land use within a subcatchment was considered to be the land use of that subcatchment.

Gutter Length and Catchbasin Density

The surface quality of each subcatchment is determined from the total length of gutter, the number of catchbasins within each subcatchment and the pollutant loadings. The gutter length was measured from a planimetric map of the city of Hamilton (scale 1" = 2000') on which the subcatchments were marked. The total gutter length was taken to be twice the length of road measured for each subcatchment. Densities representing the number of catchbasins per 10000 ft. of road were determined for single-family residential areas above and below the escarpment and for parks and institutional areas. Representative areas from the Hamilton neighbourhood maps (1" = 100') of the Chedoke Basin were used in calculating these densities. It was assumed that multi-family residential, industrial, and commercial areas had the same densities as the single-family residential area and that these densities were constant throughout the city. The catchbasin densities determined are as follows (catchbasins per 10000 ft. of road):

- | | |
|--------------------------------|------|
| 1. below the escarpment | 10.3 |
| 2. above the escarpment | 86.4 |
| 3. parks | 84.2 |
| 4. institutions (eg. McMaster) | 22.4 |

The number of catchbasins in a particular subcatchment was calculated by taking the product of the total road length and the appropriate conversion factor for the particular land use of the subcatchment. The number of catch basins for subcatchments having two or more significant land use classifications was approximated from a "weighted" calculation. The catchbasin density for residential areas above the escarpment is approximately eight times the density for areas below the escarpment. A limited field survey indicated the ratio of the densities should not be this great. The difference is probably due to incomplete information on the neighbourhood maps.

It was assumed that all catchbasins were of two standard types used by the City of Hamilton (standard concrete and standard pre-cast concrete). The catchbasin volume was calculated as an average of the volume of the two standard types.

Pollutant Makeup and Loading

The City of Hamilton has two types of street sweepers, a basic mechanical street sweeper and a vacuum-assisted mechanical sweeper. The standard sweeper has a rotating gutter broom which removes particles from the gutter area and places them in the path of a large cylindrical, rotating broom which sweeps the material onto a conveyor belt and into a storage hopper. The vacuum-assisted sweeper utilizes the gutter and pick-up brooms to loosen and move street dirt and debris into the path of the sweeper vacuum system which draws the debris into the hopper. The Regional Engineering Department has estimated that the street sweeping rates for various sections of the city are as follows:

Downtown core	once per night
Other business areas (below escarpment)	three times per week
Most main streets	once per week
Most other areas (side streets in residential areas, park)	once per month

The streets are also flushed after being swept.

At present there is no measure of the efficiency of the city's street sweepers. A study in San Jose, California (8) has shown that the efficiency of street cleaners depends upon the average loading before cleaning, the condition of the road surface, the presence of parked cars, the type of street cleaning equipment, the number of passes made by the street cleaners and the number of days between successive street cleaning operations. The dust and dirt loadings for the range of land use areas and the breakdown of these loadings into the various constituents were not available for Hamilton. Most studies have assumed default values for these measurements. A study is being conducted in the Hamilton downtown core, to investigate the efficiency of the city's street sweepers and analyse the loadings collected by the sweepers. This report should prove useful, but will not give an indication of the differences in loadings for the various land use types.

The following parameters were assumed to take the program default values:

1. The efficiency of the street sweepers and the availability in each land use for street sweeping.
2. Dust and dirt loadings for each land use.
3. The fraction of the various parameters comprising the dust and dirt loadings.
4. The initial concentration of each of the eight quality parameters in the catchbasins.
5. The exponential coefficient in the pollutant washoff equation.

In any further studies in which calibration is to be carried out it would be necessary to make estimates of these parameters based on field surveys. The sensitivity of the model algorithms to each of the parameters has been examined in our study.

Data Preparation

The FASTSWM preprocessor package, developed at McMaster, was used to prepare input data files for each drainage basin according to the 1977 release of the SWMM User's Manual. The FASTSWM package allows free-format data entry and automatic job submission thereby facilitating production.

The runoff calculations were performed in two stages. Initially, only the quantity aspects of the simulation were considered. When this section was operating satisfactorily, the input data files were expanded to include quality simulation. A calibrated, validated runoff quantity model of the system would be constructed before runoff quality was considered. When total loadings to the receiving water are to be considered, the runoff quality calculations are of little value without reliable runoff quantity results.

SENSITIVITY ANALYSIS

There is a degree of uncertainty associated with the estimation of model parameters. Each quantity and quality parameter will have some effect upon the hydrograph and/or pollutograph from a certain area. However, the effect varies considerably from parameter to parameter. For example, a small variation in the value of one parameter may cause a larger difference in the hydrograph or pollutograph. In this case, the model is said to be "sensitive" to this parameter. On the other hand, a large variation in the value of a parameter may produce only a negligible effect on the results. The model is then said to be "insensitive" to this parameter.

It is important, in any modelling exercise, to have an appreciation of the model's sensitivity. This allows the modeller to concentrate data abstraction effort on the parameters, which will most significantly affect the simulation results. Precise estimates of parameters which have only a minor effect on the results are not required.

Sensitivity analyses were carried out on both the quantity and quality parameters in SWMM.

In general, the quantity algorithms in SWMM are sensitive to the percentage imperviousness of the subcatchment. An almost linear relationship exists between percentage imperviousness and both peak flow and volume. Percentage imperviousness for an area can be estimated quite accurately given up-to-date mapping (land use plans or aerial photography).

The model displays moderate sensitivity to the subcatchment width. A large number of techniques have been proposed for estimating the width but none have proven applicable in all situations. It is preferable to calibrate the model for an area using this parameter since it incorporates inherent uncertainty.

The quantity model parameters may be listed in order of decreasing significance in terms of sensitivity:

- percentage imperviousness
- subcatchment width
- infiltration rates
- detention storage
- ground slope
- percentage of impervious area with zero detention storage.

The quality section of SWMM was found to be sensitive to changes in parameters affecting suspended or settleable solids.

Examination of the equations used in the model algorithms indicates that a variation in the amount of suspended or settleable solids washed off will have an effect, potentially overwhelming, on the amount of other constituent pollutants washed off.

The parameters affecting quality simulation and the degree to which the model is sensitive to them are summarized below:

High Sensitivity

- number of dry days (DRYDAY)
- street sweeping interval (CLFREQ)
- street sweeping efficiency (REFF)
- exponential coefficient in washoff equation (RCOEF), at low runoff rates
- dust and dirt loadings (DDFACT)
- insoluble fraction due to suspended solids (F2)
- availability factors for suspended and settleable solids (NAVAIL)
- total gutter length (GQ)

Medium Sensitivity

- street sweeping availability factor (AVSWP)
- insoluble fractions due to settleable solids (F1)
- pollutant fractions (QFACT)

Low Sensitivity

- catchbasin storage volume (CBVOL)
- initial concentration of BOD₅ in each catchbasin (CBFACT(4))
- number of catchbasins (BA)

FIELD PROGRAMME

Recording streamflow gauges were established at five locations throughout the city. Three gauges were established in the channelized section of the Chedoke Creek at the Chedoke Expressway (Hwy. 403):

- (1) Hydro substation
- (2) Hotpoint Warehouse
- (3) Main Street Crossing
(two further gauges were established in the Redhill Creek system)
- (4) Greenhill Combined Sewer Overflow (CSO)
- (5) Albion Falls

Records were also obtained from the Water Survey of Canada streamflow gauge located at the Queenston Road crossing of the Redhill Creek.

Water quality samples were collected at the five streamflow monitoring stations as well as at the outlet of the Chedoke Creek (Cootes Paradise). Sediment sampling proposed for the outlet of the Redhill Creek at Windermere Basin was not carried out by the McMaster University group during the 1980 field program. All samples taken were analyzed by the Ministry of the Environment (MOE) for BOD, total-N, total-P and suspended solids.

Two types of flow gauges were used to measure water level: pneumatic level sensors (bubbler gauge) and Stevens water level recorder.

In order to translate the water level record at each station into a discharge record, a rating curve was developed against depth at the control section. Weirs were already in existence at the Queenston Road, Albion Falls, and Greenhill sites. Weirs had to be constructed at the Mian Street, Hotpoint and Hydro Substation sites. Prior to constructing the controls, the summer students measured the channel sections. Steel boxes to house the recording equipment, the stand-pipes for the Stevens recorders and weirs for the various sites were designed and the fabrication of the steel boxes and various angle-iron brackets was contracted out.

Rain Gauges

Rain gauges were already in existence at the Mt. Albion Falls and Christie Dam conservation areas, the RBG and the Hamilton Airport at Mount Hope. Photocopies of all rain events recorded at these sites were obtained. Permission was obtained to install gauges at Garth Street, Mohawk College, Gage Park, the MOE and Stelco.

Data Interpretation

Rain Gauge Data

Charts from the rain gauges were removed after each storm unless the storm occurred outside normal working hours. The charts were corrected for time errors. One minute and five minute intensities were calculated using tip capacities of 0.01 inches/tip (0.254 mm/tip) (McMaster, Garth Street) and 0.2 mm/tip (Mohawk, Hamilton Airport, RBG).

Streamflow Data

Streamflow charts were removed from the recorders as soon as possible after a significant rain event. The charts were photocopied and the time was resolved to one minute intervals for the storm period using the most recent timing marks. The depth of water is then converted to feet and substituted into the appropriate discharge relation to yield the discharge (cfs). The flows are plotted against time to yield the hydrograph for the storm. is attached.

Water Quality Data

Water samples were analyzed by the Ministry of the Environment laboratory for suspended solids, BOD, total-PO4 and total-N. Pollutographs, which are plots of concentration (mg/l) versus time, were made for each pollutant at each location for every storm samples.

CONCLUSIONS

Looking ahead to the 1981 field season, the efficiency and quality of data collection could be improved by replacing rainfall and streamflow recorders with micro-processor units and by securing more reliable transportation. For each storm, it takes approximately 16 man-hours to abstract the data from the rain and flow gauge recorders. If the recorders were operable at Gage Park, Stelco, the MOE and Mount Albion, it would take an additional 8 man-hours to abstract this data. This data would have to be coded and keyed into a computer file as well. Maintaining the recorders would require a minimum of 8 man-hours, assuming all flow and rain gauges were operable. This amount of time would increase considerably if timing marks were to be put on charts. With the present recorders, it would be essential to have at least 1 timing mark, either before or after the storm to ensure proper synchronisation of data. In addition to man-power, the tipping bucket gauges require about \$750. (total for 6 sites) worth of chart paper to operate for 1 field season.

Micro-processors would eliminate the need for chart paper and abstraction of the data since information for each storm event could be transferred directly from the micro-processor unit to a portable computer terminal. The timing would be better synchronized with micro-processors.

Additional transportation would ensure that minimal sampling would be carried out when a few samplers were available, and that maximum sampling be completed. Several storms during the past summer were either partially sampled or not sampled at all due to transportation problems.

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